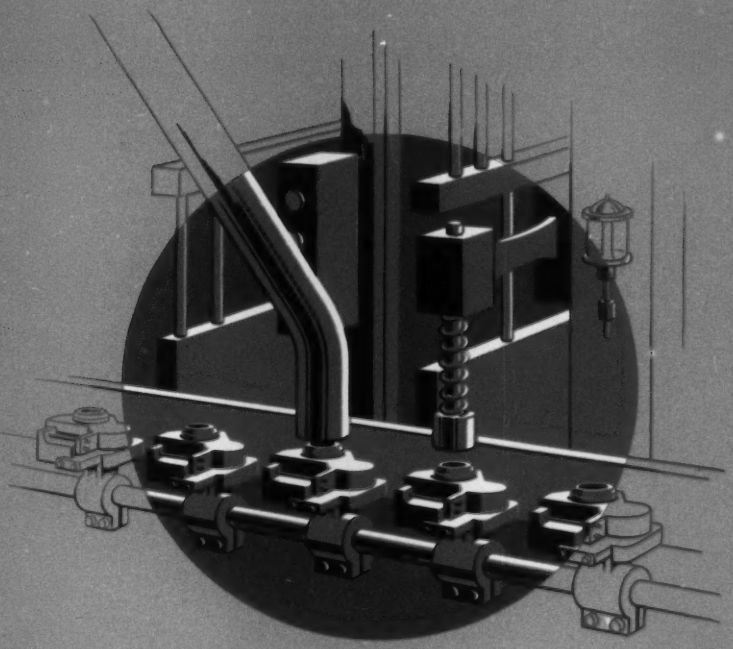
AUTOMATION

MARCH 1959



Standardizing Assembly Machines

The Magazine of Automatic Operations

- **Maintaining Numerically Controlled Machine Tools**
- **Can-Making Integrated**
- **Package Sorting System**
- **Automated Transistor Production**

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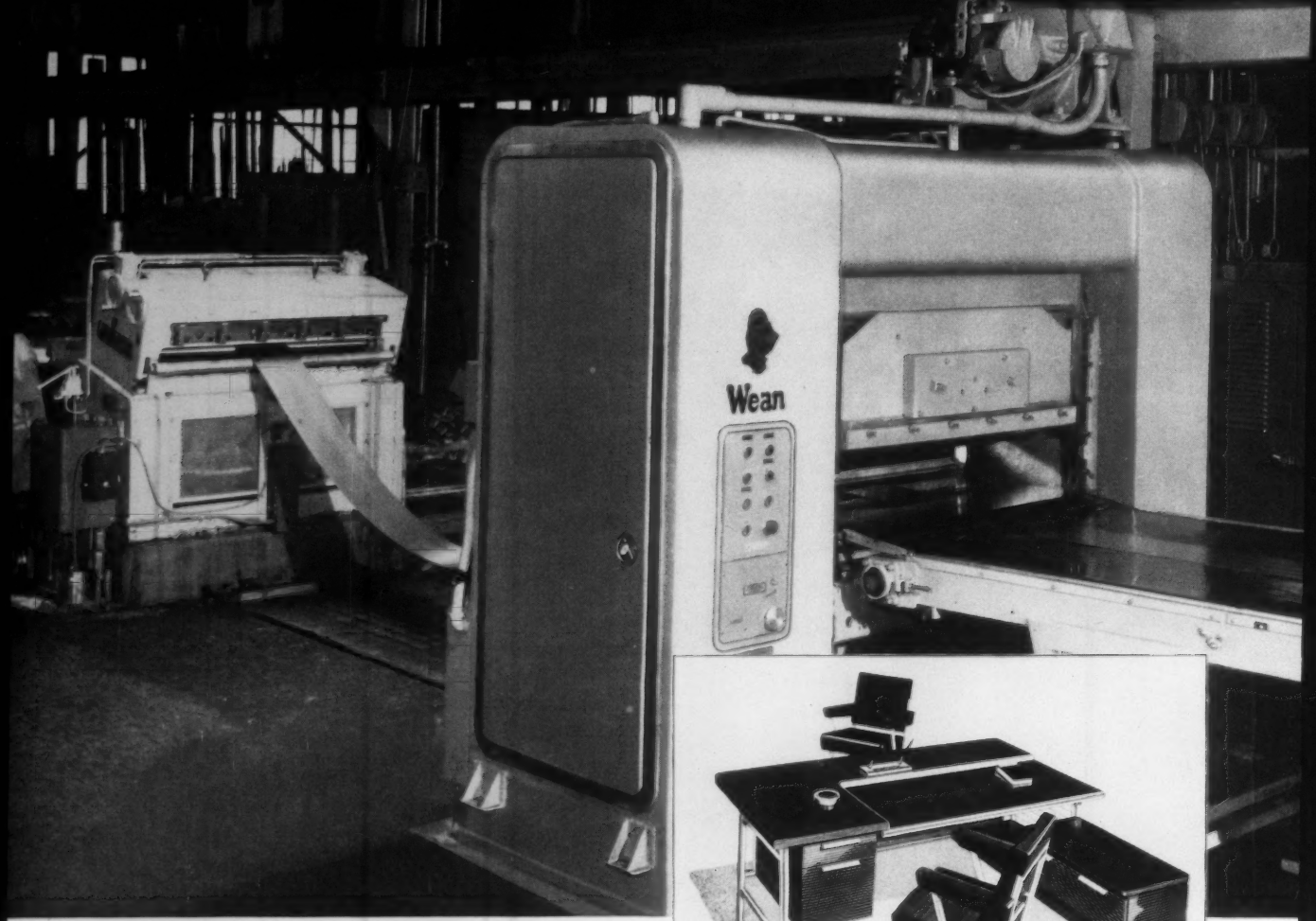
A PENTON PUBLICATION



At General Fireproofing Company . . .

Material savings alone will pay for Wean coil processing lines in first year

This leading manufacturer of metal business furniture used to buy steel in various size sheets, re-square it and then stretcher-level about 80% of the sheets. Now a Wean slitting line and Wean FLYING PRESS combination shearing and blanking line (including a built-in leveler) make it possible for GF to purchase about 90% of their steel requirements in the more economical coil form. Maintaining a large sheet inventory is no longer necessary and costly re-processing operations have been eliminated entirely.

Based on figures covering the first six months these Wean coil processing lines have been in operation, GF expects material savings in the first year alone will exceed the cost of the equipment. Company officials estimate even greater savings when peak performance of the equipment is realized and when the FLYING PRESS is utilized for simultaneous shearing-blanking operations at a future date.

If you use sheet or strip steel in quantity, it's likely Wean coil processing equipment can reduce your material production costs.

We'll be happy to send you descriptive literature; or, if you prefer, one of our sales engineers will be glad to give you full information.

WEAN EQUIPMENT CORPORATION
CLEVELAND 17, OHIO
Detroit • Chicago • Newark

WEAN

Circle 651 on Page 17

SWEET KISSES FOR SWEET CHARITY
PRESS BOTH SIDE BUTTONS AT THE SAME TIME TO RAISE SEPARATING SCREEN
KISSES $1.00
KISSES $1.00

What? Air Polices the Hands Off Policy!

We are not serious, but—

The boys might forget that a kiss doesn't involve the hands but this circuit doesn't. The screen takes care of this. When both his hands depress the actuator buttons, they start the sequence to lift the screen, but "sneaking" one hand off calls for the screen to again guard Miss "Belle-of-the-Bazaar." Our society is pretty romantic so we doubt if this "automatic bolster" will ever become popular. But as a safety feature on presses, brakes and shears the Ross non-tie-down valve, designed to keep both the operator's hands occupied, should become popular.

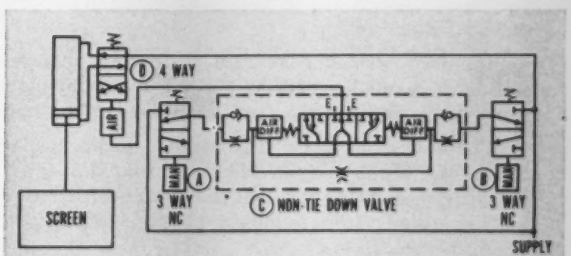
If you are interested in "two-hand safety" you are interested in a Ross non-tie-down valve.

If the operator follows instructions, then two three-way valves, either in series or in parallel, can protect his hands to a degree; but the *operator* who sets his mind to it, can beat either of these hook-ups and keep one hand free. This valve is designed to avoid one hand operation. In the Ross non-tie-down circuit, both three-way button valves are depressed at once to initiate an action and both released before another action can be initiated.

Ross OPERATING VALVE CO.

131 E. Golden Gate Ave. • Detroit 3, Michigan

The Ross non-tie-down valve is just one of the many designed by Ross to assist in creating safer press circuits. Call your nearby Ross engineer or write for full details.



SEQUENCE OF OPERATIONS

- Operating valves "A" and "B" simultaneously permits air to flow through the valve "C", shifting valve "D". Valve "D" operates cylinder raising screen.
- De-actuating valves "A" and "B" simultaneously de-actuates valves "C" and "D". Cylinder retracts and valve "C" re-sets itself for another cycle.
- Operating either valve "A" or "B" independently will *not* cause valve "C" to pass actuating air to valve "D".
- De-actuating either valve "A" or "B" independently, causes pilot air to valve "D" to be exhausted through valve "C". After that occurs both valves "A" and "B" must be released to re-set valve "C" before it will pass air to valve "D" again.

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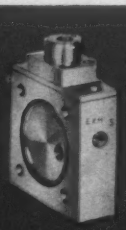
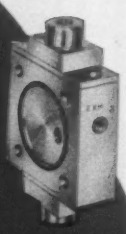
Palm Operated, Detented or Spring Return.

Lever Operated, Detented or Spring Return.

Bolt Actuated Spring Return.



Pilot Operated Spring Return.



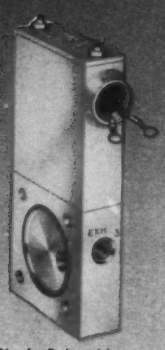
Double Pilot Operated.

HUNT

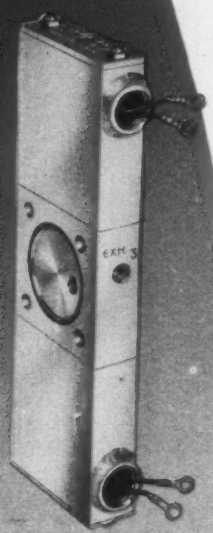
new unique Slim Line

CONTROL VALVES

Pilot Operated Bucking Cylinder Return.



Single Solenoid Spring Return.



Double Solenoid Momentary Contact.

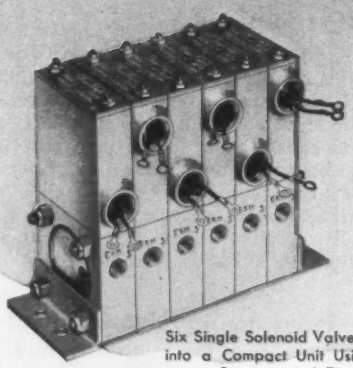
Now available with 8 types of operators. 3-way and 4-way actions. Easily manifolded into compact control centers.

● You'll like these new valves. Only 1″ thick by 3″ wide, they are exceedingly compact and light in weight; can be mounted easily on machines even when space is extremely limited.

Ideally suited for controlling small cylinders, to operate pilots and similar services. ⅛″ or ¼″ pipe tapped. Pressures to 125 p.s.i. Air, water, oil or vacuum service. Stock delivery.

Solenoid valves have the following features as standard; manual over-ride; ½″ NPT conduit connections; valve inoperative with solenoid cover removed.

The side of each valve is counter-bored, trepanned for an "O" ring, and provided with four through holes permitting up to eight valves to be manifolded together and operated from a single supply. Better get full details — now!



Six Single Solenoid Valves Manifolded into a Compact Unit Using Standard Brackets and Tie Rods.

More startling HUNT designs to come!

Send for the "SLIM LINE" Bulletin No. 581 TODAY!

40 YEARS 1919 1959

HUNT

Quick-As-Wink® AIR AND HYDRAULIC CONTROL Valves

Manufactured by HUNT VALVE COMPANY, 2071 East Pershing St., Salem Ohio

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MARCH 1959
Vol. 6 — No. 3

AUTOMATION®

A PENTON PUBLICATION

The Magazine of Automatic Operations

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automation outlook

WHAT DO THEY CONTRIBUTE?

". . . ingenious automatic machinery, marvelous combinations of old tried and new found ideas, all necessary ingredients for the successful system, achieve success not on the basis of how automatic or how new or startling they are, but how successfully they are applied for the corporate purpose. . ."—*James C. Keebler, associate editor,* *see page 27.*

MAINTENANCE NOT A PROBLEM

". . . numerically controlled machine tools have been moved from the curiosity to the production stage faster than anyone anticipated. Their use on an increasing scale . . . need not be hindered by misapprehension concerning the severity of the maintenance problem. . ."—*John O. Morin, staff engineer, Concord Control Inc.,* *see page 38.*

AUTOMATIC ASSEMBLY POTENTIAL

". . . tremendous needs for automatic assembly equipment are bound to be met. The rising cost of labor has forced the issue. Efficient equipment for assembly can show greater labor savings than any other single type of industrial equipment. . ."—*William C. Cummings, president, Gilman Engineering & Mfg. Co.,* *see page 46.*

EFFICIENT FASTENING WITH RIVETS

". . . today, with pressure growing to cut assembly costs, some manufacturers are tempted to regard riveting as an 'old-fashioned' method of assembly, and are looking for ways to replace it as existing riveting machinery is retired to the scrap heap. This is a very short-sighted policy. It isn't sensible in view of major industrial investment in developing the riveting machine to today's level of perfection, and especially in view of the major rewards that can come through imaginative use of new techniques already developed and proved by some assemblers and manufacturers of rivets and riveting machines. . ."—*John Wessel, chief engineer, Tubular Rivet & Stud Co.,* *see page 74.*

STREAMLINED WAREHOUSE ACCOUNTING

". . . the receiving and the storing of goods is only one part of warehouse problems. The order and accounting section can require almost as much labor as the warehouse itself. . . Today, however, with tab card machines making use of the mark sense principle, the man making out the order merely marks with a special type of pencil on the segment of the tab card that represents the item he wants in the warehouse. These tab cards are placed into a reading machine that cuts the card for the item requested. This card is then put through an automatic computer which bills the store on a predelivery basis and reduces the inventory. The cards are then removed from the computer to a printing machine which prints the order for the picker in the sequence in which the goods lie in the warehouse, with a copy of this billing going along with the merchandise as the manifest. To replace goods in the warehouse, the buyer is automatically advised when he should reorder. A tape for each item is inserted in an automatic typewriter which prints the purchase order, leaving the signing by the buyer and the mailing to the vender as the only manual function. With this type of accounting, the modern grocery chain can have instantaneous information and reduce inventories to a minimum with savings in space, labor, and dollars as the result. . ."—*Harry Cooke, dir. of services, Warehousing and Transportation, Penn Fruit Co.*

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BPA NEP

Circle 656 on Page 17→

. . . Fluid Power news

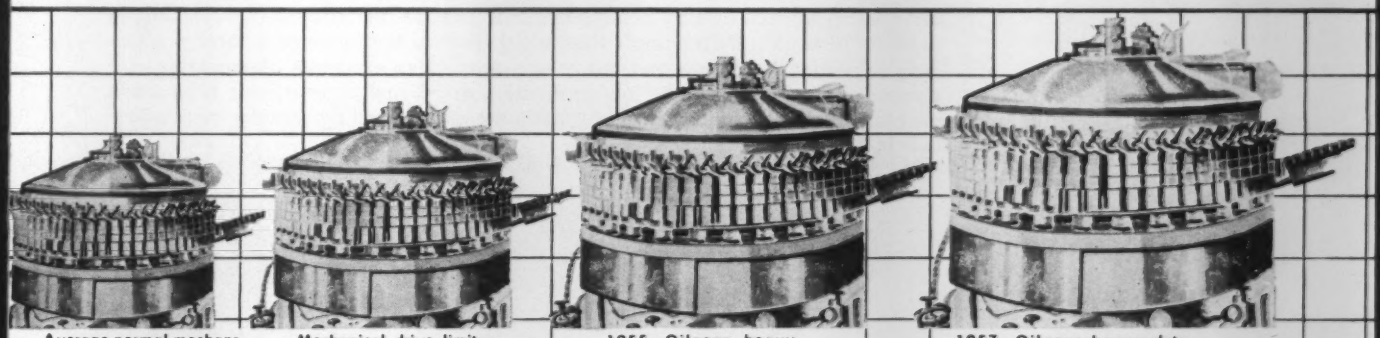
REPORT No. 11,301
HYTAC IMPROVES FILL-CLOSE PRODUCTION

From Oilgear Application-Engineering Files

HOW OILGEAR HYTAC DRIVES IMPROVE FILLER-CLOSER PERFORMANCE—TRIPLE OUTPUT

CUSTOMER: *A Large Food Machinery Manufacturer (Name withheld by request)*

DATA: This manufacturer called upon Oilgear to help solve the problem of producing a filling and closing machine that would exceed the mechanical drive limitations reached when the fill-close rate was increased from 150 to 360 12-oz cans per minute. *Summary of User Requests:* A fill-close rate of at least 425 12-oz cans per minute; accelerate to half speed in 2 seconds—to full speed in 5 seconds without jerky, jack rabbit starts that strain the equipment; reduce spillage and "deadheads"; decelerate to stop in 0.4 seconds; reduce costly losses due to under or overfilling; change speed instantly, easily—with remote control preferred; accurately hold any selected speed regardless of load or electric power variations—viscosity changes; impervious to daily sanitary washdowns; provide trouble-free, low-maintenance, continuous operation.



Average normal mechanical drive—150 12-oz cans per minute.

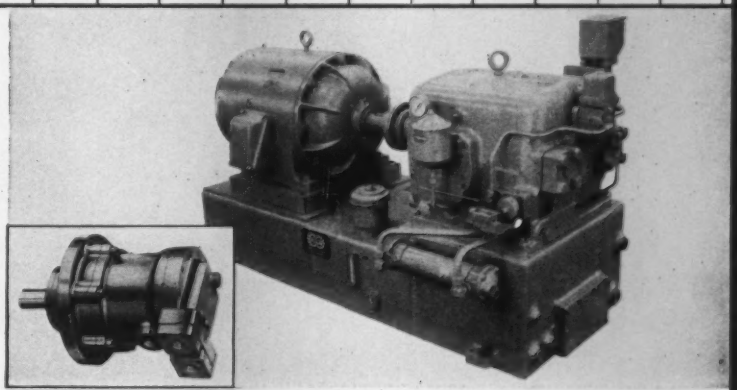
Mechanical drive limit—360 12-oz cans per minute.

1955—Oilgear heavy-duty, Size 20, Any-Speed HYTAC drive—to 600 12-oz cans per minute with improved performance.

1957—Oilgear heavy-duty, Size 35, Any-Speed HYTAC drive—to 1200 12-oz cans per minute with improved performance.

OILGEAR SOLUTION #1 (1955) Oilgear heavy-duty, Size 20, Any-Speed HYTAC (hydraulic tachometer) drives provided the first step in meeting user requests. These drives on a 6-spindle closer and 60-spout filler smoothly accelerated to full speed in 2 seconds—decelerated to stop in 0.2 seconds; a new, high fill-close rate—to 600 12-oz cans per minute without machine redesign; held *any* preselected speed within ± 0.5% regardless of load, electric power variations or viscosity changes—assuring uniform fill; reduced spillage and conveyor jams. Oilgear heavy-duty HYTAC simplified machine design and reduced maintenance by eliminating slip clutches and electric brakes—and by providing hydraulic cushioning; hydro-dynamic braking; automatic, positive protection against starting and running overloads. Remote, space-saving pump and motor location and completely sealed, leak-tight system provided protection to daily, sanitary washdowns. Users liked this improved performance and speed . . . over 50 similar installations have been made. Some users, however, continued to request higher production rates—with all of HYTAC's advantages.

OILGEAR SOLUTION #2 (1957) Due to the proven ability of Oilgear application-engineered, heavy-duty, drive and control systems to help meet user demands, this manufacturer naturally turned to Oilgear for further engineering teamwork in meeting new, greater production requirements. *RESULT*—new, higher production filling-closing machines that TRIPLE original mechanical drive output—to 1200 12-oz cans per minute with all the same desirable features outlined in the previous installations. One important addition has been made . . . new user satisfaction.



This is the newest Oilgear Power-Pak for filler-closers—Oilgear heavy-duty, Size 35 HYTAC drive components. Unit can be remotely mounted and remotely controlled for new performance, new production speed, new accuracy.

Here is but one reason and proof why designers and builders of machinery turn to Oilgear . . . why users recognize and trust the name . . . why more and more this phrase is heard, "For the lowest cost per year—it's Oilgear!"

For practical solutions to YOUR linear or rotary drive and control problems, call the factory-trained Oilgear application-engineer in your vicinity. Or write, stating your specific requirements, directly to

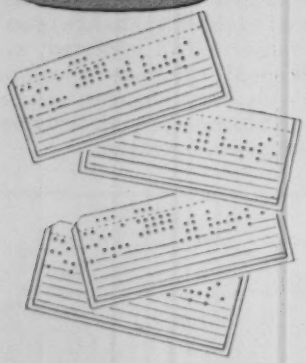
THE OILGEAR COMPANY

Application-Engineered Fluid Power Systems

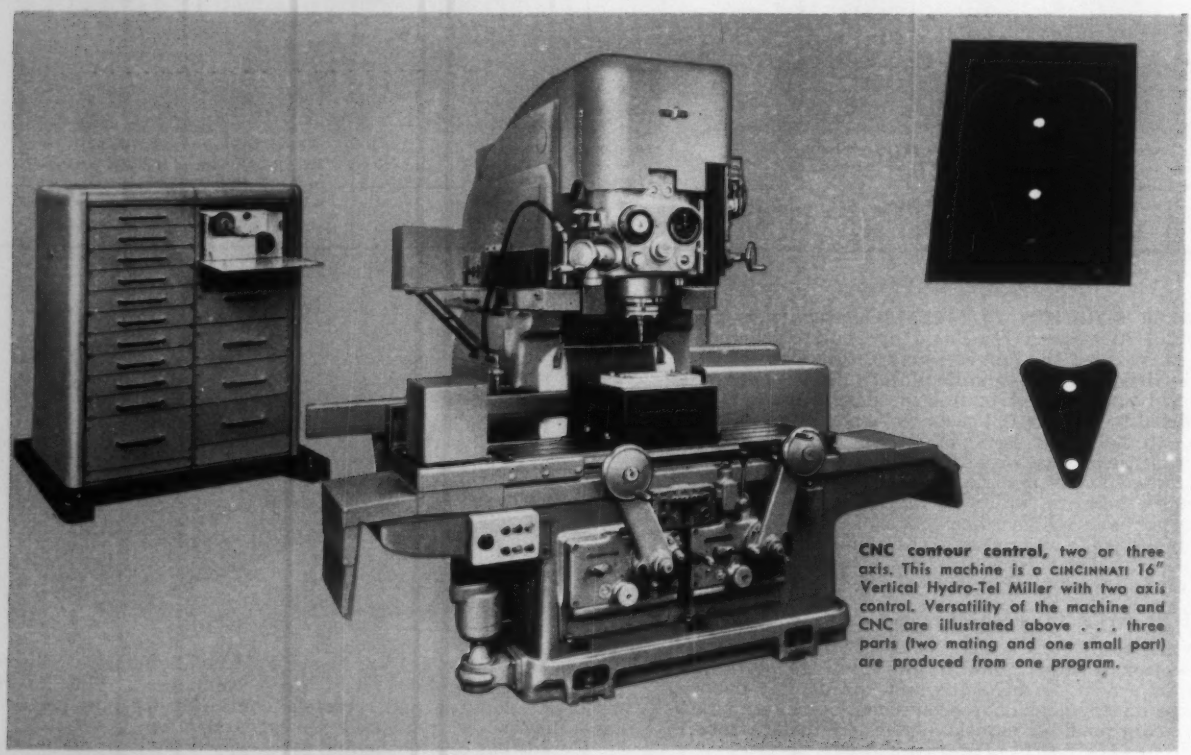
1598 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN

Cincinnati Numerical

gives you positive COST CONTROL



No more "cut and try" for machining operations. No change in setup for rough and finish cuts, new and reground cutters, right- and left-hand parts. No operator fatigue near the end of the shift. These are some of the ways in which Cincinnati Numerically Controlled (CNC) Machine Tools give you positive cost control at the machine. ¶ Other CNC advantages: **Single Responsibility** . . . coordinated, cooperative effort by Cincinnati specialists in numerical control and in every activity required to deliver completely integrated machines. **Simple Programming** . . . CNC requires fewer input data points. **Precision Machining** . . . CNC is an absolute digital-analog system, assuring precise accuracy of control. **Simple to Use, Versatile.** ¶ Cincinnati Numerical Control is the newest, most positive way to reduce lead time and many non-productive elements of excessive machining costs. Want specific job application data? Just present your production problems to us. You may obtain preliminary information by writing for publication M-2066.



CNC contour control, two or three axis. This machine is a CINCINNATI 16" Vertical Hydro-Tel Miller with two axis control. Versatility of the machine and CNC are illustrated above . . . three parts (two mating and one small part) are produced from one program.

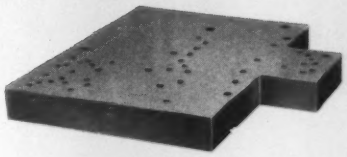
CINCINNATI®

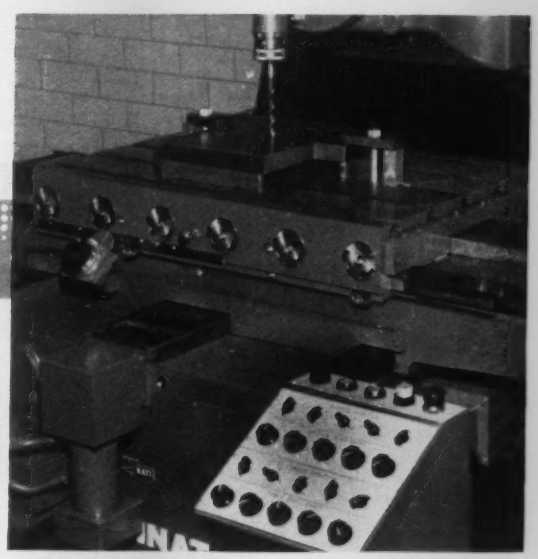
MILLING MACHINES • GRINDING MACHINES • BROACHING MACHINES • CUTTER SHARPENING MACHINES • SPECIAL

Control

at the machine

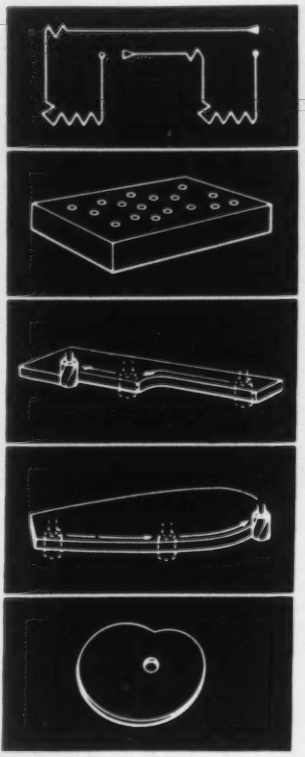
CINCINNATI





CNC position control. Drilled holes in the part (left) are accurately spaced without benefit of a jig or time-consuming positioning on the machine table.

PRINCIPAL AREAS OF APPLICATION FOR CNC



SEQUENCE CONTROL

CNC assures reliable automatic selection of feeds, speeds, spindles, coolant flow and other auxiliary machine functions.

POSITIONING

Tool-work positioning is fast, accurate. CNC eliminates need for expensive jigs, fixtures; reduces setup time.

STRAIGHT LINE CUTS

Multiple straight line cuts to exact length, and with abrupt changes in direction, can be programmed, set up and run in a fraction of the time required using conventional methods.

CONTOURING

CNC greatly reduces lead time in reproducing complex, contoured parts; eliminates need for expensive templates, masters.

CAM MILLING

Fast, extremely accurate machining of master cams is assured on CNC controlled machines. CNC system of parabolic interpolation greatly simplifies programming of cam contour.

MACHINES • HARDENING MACHINES • METAL FORMING MACHINES • COMPLETELY AUTOMATED PRODUCTION LINES

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI 9, OHIO

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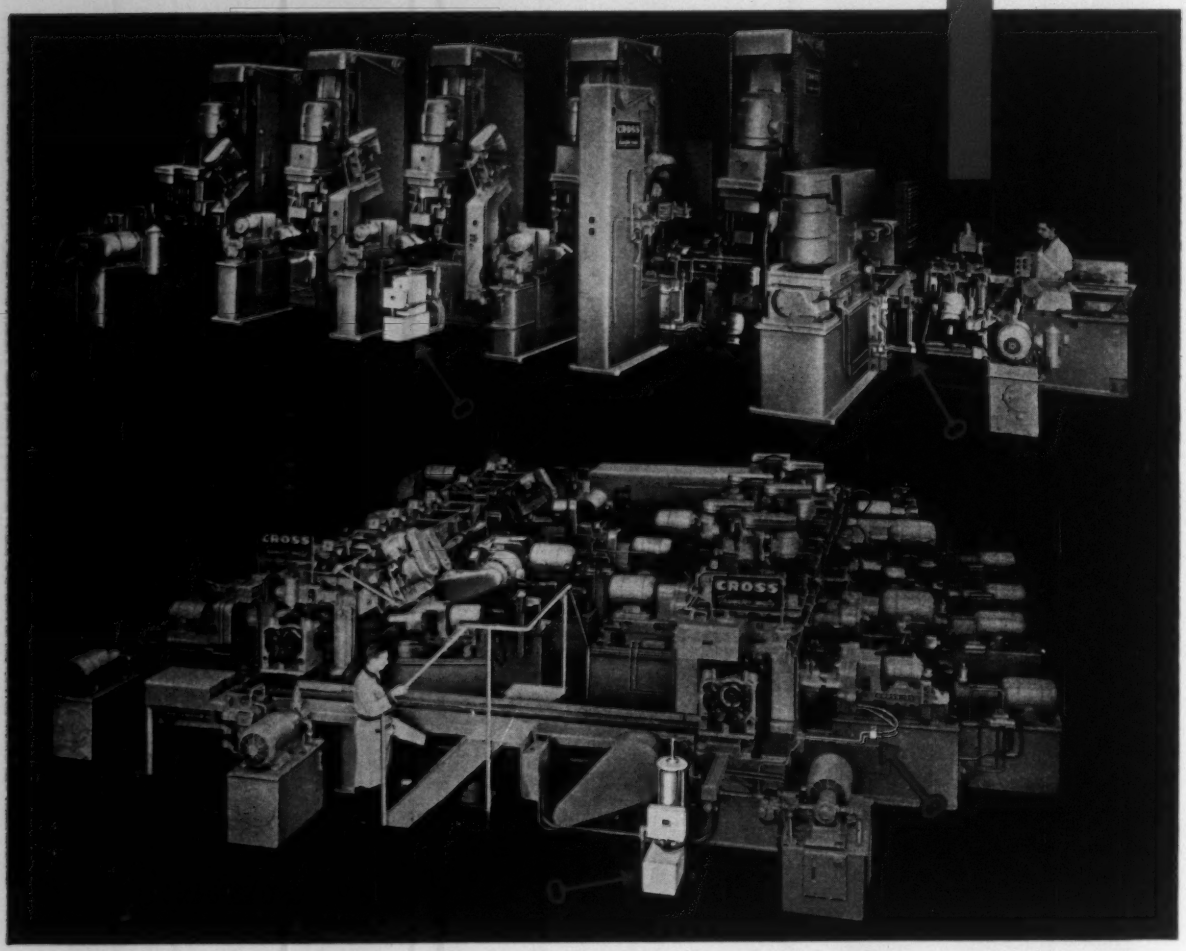
Lubrication by Farval is automatic, too, on these Cross Transfer-matics

FARVAL—
Studies in Centralized Lubrication
No. 194



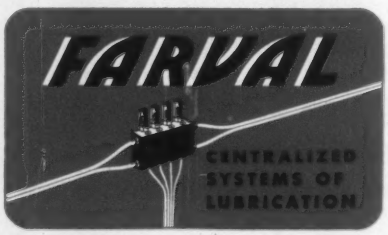
● Automation is the soul of Cross Transfer-matic machine tools. They do as many as 73 machining operations one after another on complex parts, delivering more than 100 pieces per hour.

Vital to continuous operation of these machines is the lubrication system. It, too, is automatic. It is Farval. With Farval there is no need to stop a machine for lubrication of even its most inaccessible bearings. And Farval ensures that every bearing receives the proper amount of oil or grease as often as needed.

More and more, machine designers, engineers, and production men are employing Farval to protect the large investments represented by automated production lines. Farval's own sales engineers are available and eager to work with industry to meet any and all problems related to centralized lubrication. For Bulletin 26-R and details of our engineering service, write The Farval Corporation, 3265 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm and Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

KEYS TO ADEQUATE LUBRICATION—
Wherever you can see these Farval manifolds, dual lubricant lines, and central pumping station, you know a machine is being properly lubricated.



Circle 657 on Page 17

AUTOMATION news

Today's events and developments in the field of automation

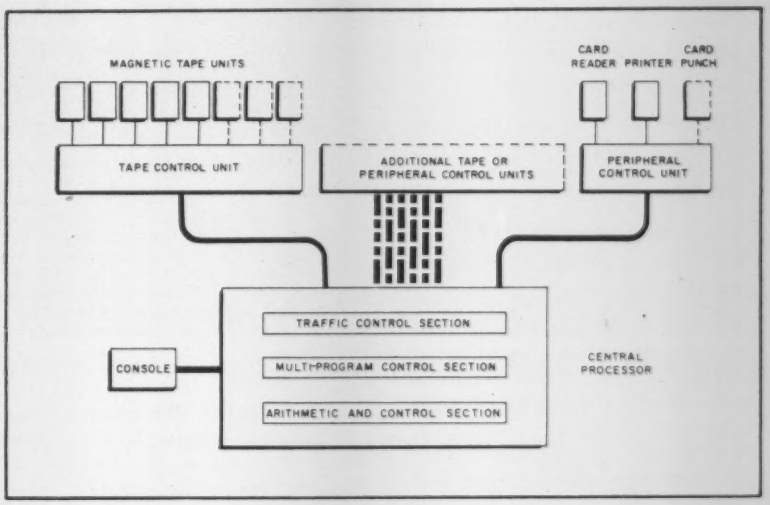
Data Processor Accepts Eight Programs Simultaneously

MODULAR design of a medium-scale data processing system recently announced by Datamatic, Div., Minneapolis - Honeywell Regulator Co., permits ready expansion to meet growing business requirements. Ultimate capacity of the system is said to be such that no application can outgrow it.

The compact, transistorized central processor, called the Honeywell 800, has the ability to perform decimal arithmetic for business applications. For scientific calculations, it can perform both fixed and floating-point binary arithmetic.

A "parallel processing" principle enables the performing of up to eight "device-limited" programs in the same time that a computer with sequential processing would require for one program. A device-limited program is one whose speed is held to that of an electromechanical device such as a card reader, printer, or magnetic tape recorder. Typically, these devices operate at 1000 to 3000 operations per second.

If a "computer-limited" program (one in which the time spent in making peripheral transfers is small compared with the computation time) is applied to the system, it will step through its instructions at 30,000 operations per second. If two such programs are applied simultaneously, each will proceed at 15,000 operations per second. Computer-limited and device-limited jobs may be operated in parallel, with slowing of the computer-limited jobs by only the rates required to operate the added devices.



SCHEMATIC of a new transistorized data processing system recently announced by Datamatic, Div., Minneapolis-Honeywell Regulator Co., shows the parallel processing principle which enables the system to perform up to eight programs at the same time. The traffic control section monitors up to 16 input-output trunks and effects the necessary channel connections at the proper time between these trunks and the central processor.

As an example of the time and efficiency gains possible with parallel processing, an investigation revealed that five inventory programs and an engineering problem requiring computation could be processed in 4 hours instead of the 14 hours and 36 minutes that would be required by conventional sequential programming. The inventory programs involved the reading, sorting, and magnetic recording of transaction cards; extraction of information from a master file; and printing of production orders, purchase orders, and several types of reports.

The comparatively simple three-address order structure employed conserves time and memory capacity, and facilitates programming. A complete checking routine, from input through output, includes a tech-

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Third Conference On Manufacturing Automation

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For Details, See Pages 12 and 126.

nique for instantaneous correction of lost or garbled information.

Rental of data processing systems will carry a 2-year option to buy the equipment. In minimum form with 4094 words (48 bits per word) of memory, but without any magnetic tapes, the rental fee for the Honeywell 800 will be $11,000 per month. A more elaborate installation similar to that shown in the diagram will rent for approximately $23,300 per month. A factor of 48 applied to the monthly rental rate gives an approximate figure for estimating the purchase price of a system.

Survey Affirms Growth Of Plant And Equipment Leasing

LEASING of plant and equipment is gradually increasing among American manufacturing companies according to a recent survey conducted by the National Industrial Conference Board. Out of 221 manufacturers surveyed, 71 companies reported that they are now renting more equipment and facilities than they did 5 years ago. Of the remaining firms, 110 have not experienced any over-all increase in rental activity, 7 companies reported a decrease in their rental program, and 33 firms did not respond to the question.

Items such as warehouses, office equipment, automobiles, and trucks contributed substantially to the over-all increase in rental volume. Production machinery and machine tool rentals also increased, but such items are still only a small part of the over-all leasing volume.

Most of the firms surveyed by the NICB believe that the primary purpose of leasing is to conserve or stretch working capital. However, the companies also pointed out that leasing is not always the cheapest way of acquiring facilities. Other reasons reported for renting facilities were: Provide convenience and flexibility, short-term use, avoid obsolescence, eliminate service and maintenance problems, tax advantages under certain conditions, problem of selling unwanted equipment and facilities.

Deterrents to the growth of rental practices include the relatively high prices which many lessors impose as a safeguard against hazards, the liberalization of depreciation allowances on owned property which makes renting less attractive, and the uncertainty of potential tax benefits under certain lease agreements.

CLOSED-CIRCUIT television system has been installed at the Deepwater Generating Station of Atlantic City Electric Co. to allow for remote viewing of a boiler water gage glass. This installation provides the operator in the control room with a visual check of the water level against recorded levels produced by instruments. Inset shows an Allen B. Du Mont Laboratories Inc. television camera focused on the remotely located water gage and transmitting a picture to the control room. A two-color gage is used for better discrimination of the water level. By using a special lens filter on the camera, the water level appearing on the television monitor appears black (although actually green), and the area above the water level appears white (actually red). The Du Mont surveillance system was installed by Sound Systems Inc.

Gas Powered Warning Horns Protect Against Fire Damage

INEXPENSIVE warning horns, powered by their own self-contained supply of a nonflammable liquefied gas and triggered by a simple heat-sensitive device, can help prevent tragedies such as the recent Chicago school fire by warning of fire conditions before a blaze gains headway.

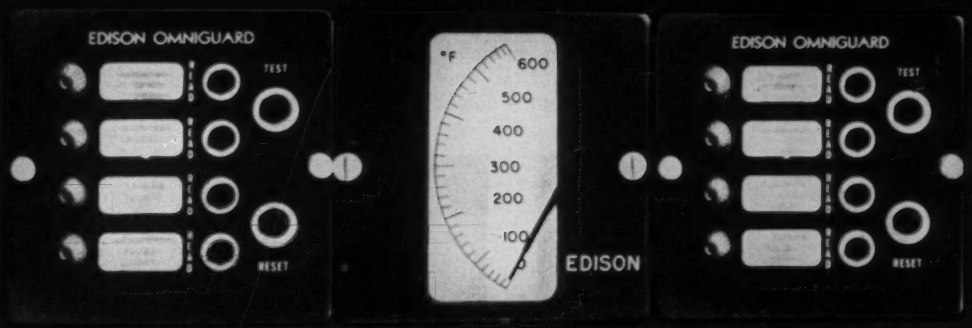
According to the E. I. Du Pont De Nemours & Co., the devices emit an ear-piercing sound (rated at 100 decibels or more) for 5 minutes or longer after being activated by heat. Fusible metal plugs, which melt at a predetermined temperature and release the liquefied gas to blow the horns, make these safety devices self-contained units, requiring no wiring or external controls. Typical propellent used in the devices is Freon which readily changes from a liquid to a gas when released by the fusible plug.

Prices of recommended warning horns bearing Underwriters' Laboratories approval range from $25 to $35, depending on the size and construction. The units are refillable after they have been actuated and at least one manufacturer replaces actuated units at no charge under the original purchase price. These devices are manufactured by the Evergard Fire Alarm Co. Inc., Falcon Alarm Co., and Standard Alarm & Signal Co.

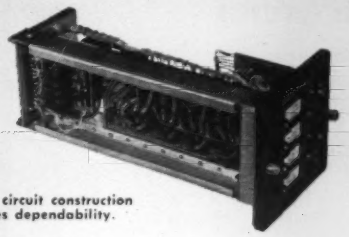
Modest Rise In Capital Spending Forecast For 1959

OPTIMISM will be the keynote for 1959 according to the latest review of current economic conditions by the Guaranty Trust Co. of New York. The trend of business is upward, and from all appearances the economy is still in the relatively early stages of the recovery movement.

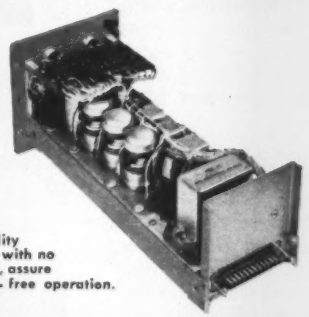
In the fourth quarter of 1958, the annual rate for GNP approximated $452 billion which was $13 billion more than in the previous 3-month period. At this level, GNP



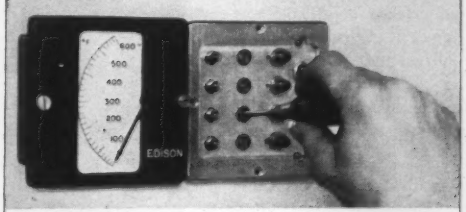
Model 310 Edison Omniguard with Model 311 Indicator — a single indicator can read any number of temperature points.



Printed circuit construction increases dependability.



Highest quality components, with no moving parts, assure maintenance-free operation.



Easy access to all components permits quick temperature settings and monitoring system changes – at any time.

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new model 310 omniguard temperature monitor... unmatched for versatility

The new Model 310 Edison Omniguard provides the simplest, most dependable temperature detection system yet devised... for both small and large installations.

The Omniguard system is reliable... flexible... economical. You order only the plug-in units needed, add new units as your monitoring needs expand.

Check these features of the new Edison Omniguard:

1. **VERSATILE:** One instrument can be used for both normally open and normally closed annunciator... for alarm or for shutdown of equipment.

2. **FLEXIBLE:** Quick, inexpensive system changes and additions . . . easy tie-in with any type annunciators or cut-off switches.

3. **DEPENDABLE:** Rugged design with highest quality components, no fragile moving parts.

4. **SIMPLE:** Single indicator reads any number of temperatures, needs no periodic adjustment. With a minute's briefing, *anyone* can operate the simple Omniguard monitoring system.

5. **LOW COST:** Plug-in units can be custom-tailored to your exact requirements . . . order additional units only when needed.

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in real terms was in all probability very close to the prerecession peak. A GNP rate of $475-480 billion (in terms of present prices) seems easily possible by the end of 1959. This range allows for a considerable slowdown from the rate of gain in the latter half of 1958. It is clear that expansive tendencies predominate in the economy at this time and that there is no serious downward push, or threat of one, in the picture.

At this time it does not seem that capital outlays will rise appreciably in 1959. However, since October there has been further confirmation that the recovery movement is solidly grounded, and this fact has

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Top Talent Sparks Third Manufacturing Automation Conference

H. H. YOUNG

ROBERT A. LOWE

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GEORGE L. WEISER

FIRST SESSION of the Third Conference On Manufacturing Automation convenes on the campus of Purdue University, Lafayette, Ind., on Monday, March 23, 1959. Leading off this 3-day event will be a 5-man panel from International Business Machines Corp., Endicott, N. Y., presenting a case study of the elements necessary in *Developing Automation for Flexibility of Output.* **Keith B. Bennett**—project engineer, Test Equipment Engineering; Electrical Engineering graduate of Stanford University—will discuss organizing the attack on an automation problem. . . . **George O. Philip**—project engineer in charge of Machine Tool Automation, Mfg. Research; Mechanical Engineering graduate of Lafayette College and M.S. degree from Syracuse University—will cover a study of operations. . . . **Alfred H. Johnson**—project engineer and manager of Mfg. Research; Aeronautical Engineering graduate of Rensselaer Polytechnic Institute—will discuss product design for automation processes. . . . **William E. Andrus Jr.**—manager of Applied Computation, Data Processing Div.; Mathematics graduate of Syracuse University—will highlight data processing as a tool in product design. . . . **Richard D. Seiler Jr.**—technical ass't. in General Mfg. Engineering; Electrical Engineering graduate of Lafayette College—will discuss the economic justification of an automation program.

H. H. Young—assoc. prof., Dept. of Industrial Engineering, Purdue University; B.S. degree in Mechanical Engineering and M.S. degree in Industrial Engineering from Case Institute of Technology—will discuss *Industrial Engineering's Role in Automating Processes.* . . . **Robert A. Lowe**—managing partner, R. A. Lowe & Co.; M.S. degree in Industrial Engineering from University of Wisconsin—will talk on *Cost Analysis and Machine Replacement.* . . . **Armin C. Frank Jr.**—manager-manufacturing, Vacuum Cleaner Dept., General Electric Co.; Mechanical Engineering graduate of Yale University—will discuss *Manufacturing Engineering and Machine Procurement.*

George L. Weiser—chief process engr., Delco-Remy Div., General Motors Corp.; associated with almost every process and development project undertaken at Delco-Remy since 1927—will present *Assembling Complex Devices.* . . . **James R. Sebastian**—president, Rapids-Standard Co. Inc.; A.B. degree from Albion College and graduate work at University of Arizona—will discuss *Handling as the Key to Automation for the Small Company.* . . . **Allan Harvey**—president, Dasol Corp.; Industrial Engineering graduate of University of California—will present a systems approach to *Handling Products for Distribution.*

Dr. Joseph F. Manildi—general manager, Thompson-Ramo-Wooldridge Products Company, B.S., M.S., and Ph.D degrees in Electrical Engineering from California Institute of Technology—will discuss *Modern Development in Control.* . . . **W. E. Brainard**—chief engr., Servo Machine Tool Div., Kearney & Trecker Corp.; graduate of University of California and University of Southern California—will present *Numerical Control of Production Machines.*

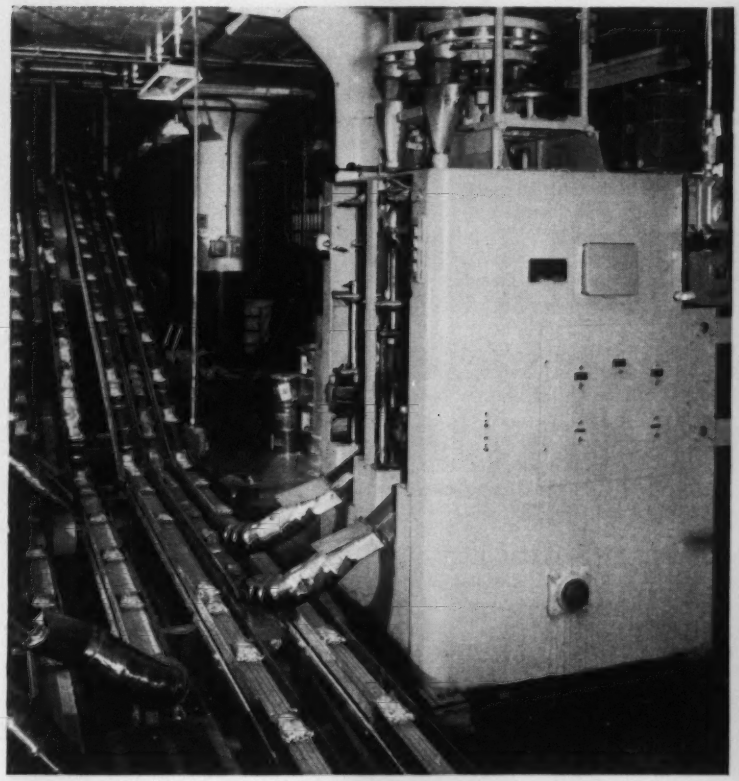
Speaking during the Monday buffet lunch will be **William Alden,** president, Automation Management Inc., on *Pioneering in Automation;* Tuesday lunch, **E. W. Lehmann,** prof. emeritus, Agricultural Engineering, University of Illinois, on *Automation on the Farm;* Wednesday lunch, **O. C. Levy,** vice president, American Totalisator Co., on *Automating the Horses.* Tuesday night Banquet speaker is **Leon Greenberg,** chief, Div. of Productivity, U. S. Dept. of Labor, speaking on *Guaranteed Annual Automation.*

JAMES R. SEBASTIAN

ALLAN HARVEY

DR. JOSEPH F. MANILDI

W. E. BRAINARD



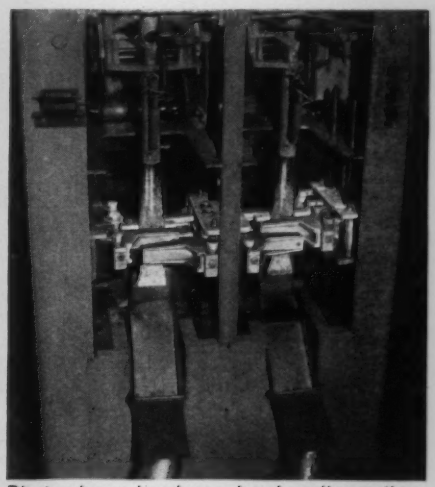
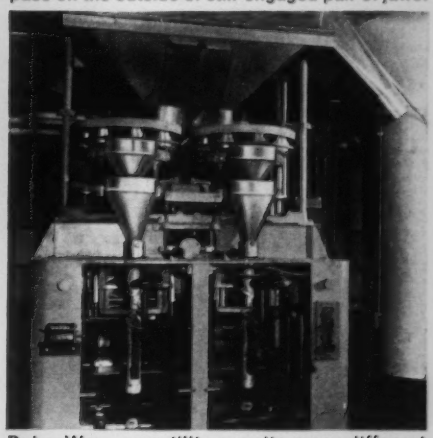


Photo shows hand-over-hand sealing action. Lower jaws, now disengaged, start to go up and pass on the outside of still-engaged pair of jaws.



Robo-Wrap versatility permits many different feeding arrangements. At General Mills, there is a volumetric feeder leading from storage hopper supplied from floor above.

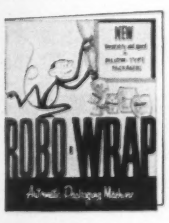
General Mills Pick-A-Pack Package offers five tasty breakfast foods—Wheaties, Cheerios, Kix, Trix, and Sugar Jets—in one attractive carton.

Why General Mills chose Robo-Wrap for Pick-A-Pack

This new Robo-Wrap at General Mills' Chicago plant will soon be joined by 2 more machines—because it has been proved that Robo-Wrap increases the efficiency and economy of their packaging operation.

The Robo-Wrap forms, fills and seals pillow packages. Under production line conditions at General Mills, the Robo-Wrap cruises at 100 bags a minute and can run at 120 . . . it provides a better seal and fewer rejects even at these high speeds because its unique hand-over-hand action holds jaws in sealing position for a longer time . . . it minimized work stoppages due to torn paper roll stock because the combination mechanical and hydraulic jaws exert a strong, jerk-free pull . . . it is easily adaptable to handle a variety of other products.

Robo-Wrap packages in cellophane, paper, poly, plastic or laminates. See how it can answer your needs for speed, dependability, easy maintenance and adaptability.



Write for Illustrated Robo-Wrap Folder that demonstrates features and advantages important to you.

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probably already produced some upgrading of investment plans. If the business climate continues to improve, past experience suggests that additional upgrading will take place. No one can reasonably expect a vigorous, expansion-type boom during the coming year, yet the compelling, ever-present need on the part of corporations to improve efficiency could bring about a significant rise in modernization expenditures. Against this background, it would not be surprising if outlays for new plant and equipment should be running several billion dollars higher at the end of 1959 than at the present time.

Principal reason for optimism with respect to 1959 is that basic conditions favor a further rise in consumer spending for both nondurable goods and services. The most important factor underlying this outlook is the rising trend of disposable income. Significant also is the fact that there has been no rise in consumer debt during the past year. It seems entirely possible that personal consumption expenditures may be running $12-13 billion higher at the end of 1959 than at the present time. Actually, this could well prove a conservative anticipation.

Westinghouse Wins Award For Optimizing Control System

MACHINE which duplicates the informed behavior of a human being in controlling complicated industrial manufacturing processes has won for Westinghouse Electric Corp. the 1958 Industrial Science Achievement Award of the American Association for the Advancement of Science.

The machine, called Opcon for "optimizing control," is based upon a new concept in control systems. It replaces the preset, routine functions performed by a conventional control system with a human-like process of reaching a logical conclusion through experiment. Opcon reverses a trend toward increasing complexity in automatic control of industrial processes. Traditional approach has been to study in minute detail all the conceivable variables

DATA HANDLING TRENDS . . .

HIGH SPEED PRINTING—Transistorized printer system developed by ElectroData Div., Burroughs Corp., selects, edits, and prints out data from a computer or magnetic tape at rates up to 1225 alpha-numeric or 1500 numeric lines per minute. Plugboard controls make it possible to rearrange, edit, and merge records without preparing special working tapes. Automatic editing includes the insertion of blanks, decimals, commas, dollar signs, check-protecting asterisks, and zero suppression. A high speed drum in the printing unit has 120 print positions with 51 solid-face characters per position. When integrated with Burroughs 220 electronic data processing system, the printer can be used to turn out multiple forms used in billing, management reporting, customer statements, inventory, and other high volume printing applications.

EXPANDS DATA CENTER—Carborundum Co. is adding a second Sperry Rand Corp. Univac I to its Niagara Falls, N.Y., electronic data processing center. The presently installed Univac I is operating on a 3-shift schedule to handle order processing, inventory records, billing, sales accounting, salaried and hourly payrolls, property accounting, and depreciation records. The computer is also used by the R & D Div. for scientific and engineering problems. The new Univac I will be used to handle additional operations introduced into the system on a progressive basis during the next 5 years.

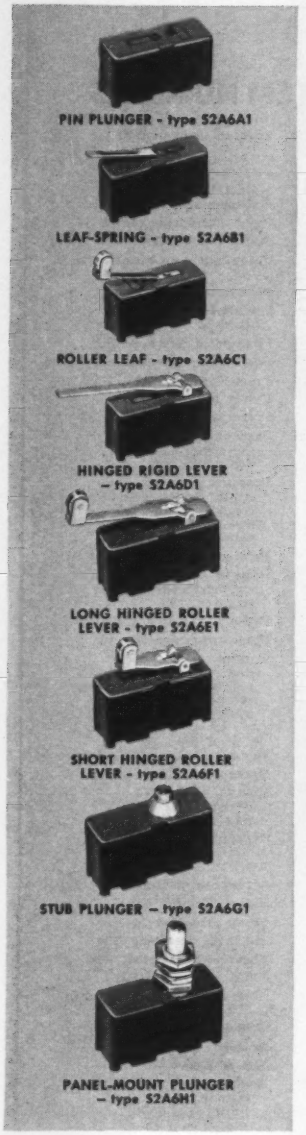
SEARCHES LITERATURE FAST—Automatic information retrieval system at Aircraft Gas Turbine Div., General Electric Co., uses International Business Machines Corp. 704 computing equipment to search out abstract information for scientists and engineers. At present, more than 30,000 abstracts of technical documents are recorded on 3 tapes, and over 7000 key words are used to describe the data. System can search the entire list of key words in less than 3 minutes and can produce printed abstracts in less than 15 minutes. Manual search by trained personnel would require up to 14 hours to acquire same information. System can accommodate 1 million abstracts, 56 million file numbers, and can perform up to 99 simultaneous searches.

READS PRINTED STUBS—Character sensing machine, called the Eye, has been developed by Intelligent Machines Research Corp. to read cashier stubs and produce cash application punched cards at a rate of 100 per minute. Characters, which appear normal to the human eye, are printed on the stubs by special type wheels installed in conventional business machines. The Eye uses a scanner to read the stubs and convert the character images into video signals. A small digital computer analyzes the signals, identifies characters by stroke pattern, and stores data in a memory until entire stub is read and checked. Output of the computer memory then operates on IBM summary punch to produce the cash cards.

ANNOUNCES BUSINESS DATA SYSTEM—Radio Corp. of America has announced the development of a transistorized, general purpose electronic data processing system—the RCA 501—which features transistorized auxiliary input and output equipment. Heart of the system is a transistorized computer which has its own high speed magnetic core memory storage unit. Linked to the computer are one or more magnetic tape storage stations. The core memory has a capacity for 16,384 characters, each representing a letter, numeral, or punctuation mark. With the addition of other magnetic core units, the capacity can be increased to 260,000 characters. Up to 63 tape stations can be harnessed to one computer, each capable of accepting 8.5 million characters. Results of the computer are fed to a printer which has an output of 600 lines per minute.

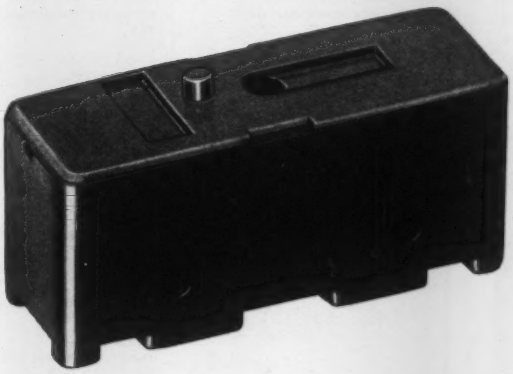
ADDS TAPE READER—Computer Div., Bendix Aviation Corp., has added a new photoelectric paper tape reader to its G-15 computer accessory line. The new reader operates at 400 characters per second and will stop or start on one character. Any five, six, or seven-channel numeric code can be read and translated to G-15 code. The unit can be easily loaded and unloaded since no reels are used. A special winder keeps the tape in a neat roll at all times.

OFFERS PUNCHED CARD SYSTEM—Low cost system of punched card data processing designed specially for small businesses has been announced by Remington Rand Univac Div., Sperry Rand Corp. System consists of four basic pieces of equipment—an alphabetical punch, a sorter, an alphabetical tabulator and summary punch, and a reproducing punch. Operating speed of the system is 60 cards per minute. System can be adjusted to perform faster, and additional units can be added as desired. Remington Rand states that cost of system is less than cost of comparable manual systems.


PIN PLUNGER - type S2A6A1
LEAF-SPRING - type S2A6B1
ROLLER LEAF - type S2A6C1
HINGED RIGID LEVER - type S2A6D1
LONG HINGED ROLLER LEVER - type S2A6E1
SHORT HINGED ROLLER LEVER - type S2A6F1
STUB PLUNGER - type S2A6G1
PANEL-MOUNT PLUNGER - type S2A6H1

NEW HiPAC PRECISION SWITCHES

Series S2A



UNIQUE BRACING PREVENTS BLADE DAMAGE
RIGID CASE ASSURES DISTORTION-FREE MOUNTING
MOLDED-IN BARRIERS POSITIVELY SEPARATE TERMINALS

take on *high current* in control and indicating circuits

Hetherington's new HiPAC Precision Switches represent the latest refinements of the switchmakers' art. Compact and precision made in every detail, these small high-current switches provide carefully controlled force and movement characteristics for unsurpassed repeatability in critical applications. One-piece blade actuators of selected beryllium copper operate against solid silver contacts to give long, stable mechanical and electrical life with uniformly low contact resistance.

Here's a capsule run-down on the new Series S2A Switches: rated at 20 amps., 125/250 volts ac, 1 and 2 horsepower ac; U.L. Inspected; SP-DT circuit; unusually rigid ammonia-free phenolic case; interchangeable with other precision switches of equivalent ratings; built-in safety limit to prevent over-travel damage to blade; molded-in barriers to provide long creepage paths and positive separation between terminals and leads.

HiPAC Precision Switches are available with any of eight actuators. Prompt delivery of samples may be obtained from over 50 leading electronic parts distributors — use part numbers shown above to order. For complete specifications, write for Hetherington Bulletin S-9.

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SEE US AT THE IRE SHOW BOOTH 3805

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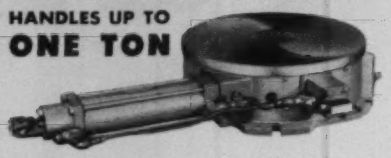
AIR-HYDRAULICS INCORPORATED

NEW TABLE

HANDLES UP TO ONE TON



Index 30 positions per minute when equipped for 6 station operation with Air-Hydraulics' new Model 2400 (24" dia.) air index table ● Handles work loads up to one ton ● Bolt larger diameter plates to 1¼" ground steel table top for greater table area ● Repetitive shock loads are no strain ● 4" bore index cylinder develops power stroke 13 times line pressure for extra power and speed—no override ● Adjustable cushion and speed control ● Locking cylinder, mounted on table's centerline, means positive index every time— =.0015" ● Limit switch keeps basic equipment from moving until table is "locked in" ● Pressure lubrication, tapered roller bearing on shaft and ample bearing surface at circumference assure friction free operation ● Operates on 60 to 175 psi line pressure ● 4, 6, 8 or 12 stations with clockwise rotation standard ● Others, including counterclockwise rotation, and from 3 to 60 positions to order.

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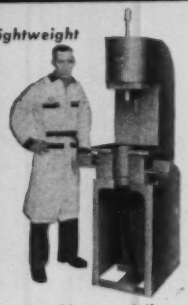
AIR-HYDRAULICS INCORPORATED

A NEW PRESS FOR LESS 15 TON—AIR HYDRAULIC

● *Durable* ● *Lightweight*
● *Compact*



Model C-500. A versatile press with 8¼ inch throat. 6 inch stroke, 2 inch adjustment, equalized pressure full length whether feather-touch or full blow. 100 pound air line gets up to 21 tons delivery. Stand or bench installation. Moving parts protected in handsome housing. Adjustable speeds. Hand, foot or automatic controls. Simple, tireless and safe operation. Women like it. Long, trouble-free service. Easy to maintain and repair. For all kinds of materials. Thickness no problem. Rivets, flanges, broaches, stakes, crimps. Many other uses.

WRITE TODAY FOR INFORMATION REGARDING APPLICATION TO YOUR JOB . . . AND HOW LITTLE IT WILL COST YOU.

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For additional free information circle item number on an inquiry card. Fill in your name, title, address, etc.—Drop it in the mail—Your request will receive prompt attention and will be filled directly by the manufacturer.

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428	468	508	548	588	628	668	708	748	788	828
429	469	509	549	589	629	669	709	749	789	829
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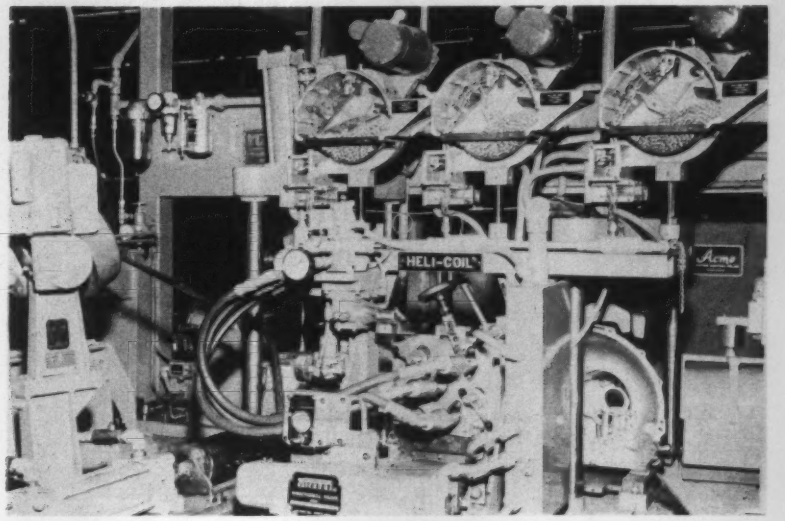

TRANSFER LINE built by Majestic Tool Co. drills and taps 105 holes in automatic transmission housings at the Automatic Transmission Div., Ford Motor Co., Sharonville, Ohio. Integral part of the transfer line is a high-speed inserting machine which automatically installs wire thread inserts and breaks off the driving tangs. Designed and built by Heli-Coil Corp., the inserting machine is equipped with two stations. At the first station, inserts are fed and oriented from three overhead hopper units to three inserting tools. As a transfer carriage moves the tools to the housing, the inserts are wound through a prewind tip into the casing. The second station is equipped with three impact punches which break off the insert driving tangs. Output of the transfer line is 120 housings per hour.

which could affect the output of a process. A network of regulating devices is then placed on these input variables, and a central computer, which is fed with mathematical equations and parameters governing the process, adjusts them automatically to obtain the desired output.

In the optimizing control system, when some uncontrolled input variable upsets a process and lowers its yield, Opcon begins to experiment automatically—within limits known to be profitable—with the control settings which will most quickly bring the yield back to a maximum. At each experimental step, the machine remembers the action taken and decides whether the step was a success or failure. The next step is based on this decision and is, therefore, the one most likely to lead to another successful move. Thus, each step is experimental, with the machine's built-in intelligence designed to produce the greatest over-all success in the least number of steps.

An Opcon optimizing control now is automatically performing tests on the entire output of capacitors in a new Westinghouse plant in Bloomington, Ind. A more advanced version of the system has been installed on a dehydrogenation pilot plant of Dow Chemical Co. Another system is being used to run a complete distillation column in a refinery of the Sun Oil Co.

SPOTLIGHTING PEOPLE

E. H. Schaefer named chief of a newly established Manufacturing Engineering Dept. at Autonetics, Div., North American Aviation Inc. . . . **J. Vance Foster** appointed manager of Applications Engineering at Potter & Brumfield Inc. . . . **O. M. Bundy** named manager of New Products Div., Clark Controller Co. . . . **Wallace S. Whittaker** elected chairman of the Executive Committee of Pratt & Whitney Co. Inc. . . . **Charles H. Single** appointed computer engineering manager for Berkley Div., Beckman Instruments Inc. . . . **J. T. Holley** named factory manager of the Los Angeles plant of Chainveyor Corp. . . . **Lloyd A. Thacher** appointed general manager and sales manager of Proximity Transducer Div., Electro Products Laboratories. . . . **Irving R. Schwartz** appointed field sales manager of the Autronic Div., Swartwout Co. . . . **William W. Scull** elected vice pres-

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The "LP" Pillow Block

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Circle 662 on Page 17

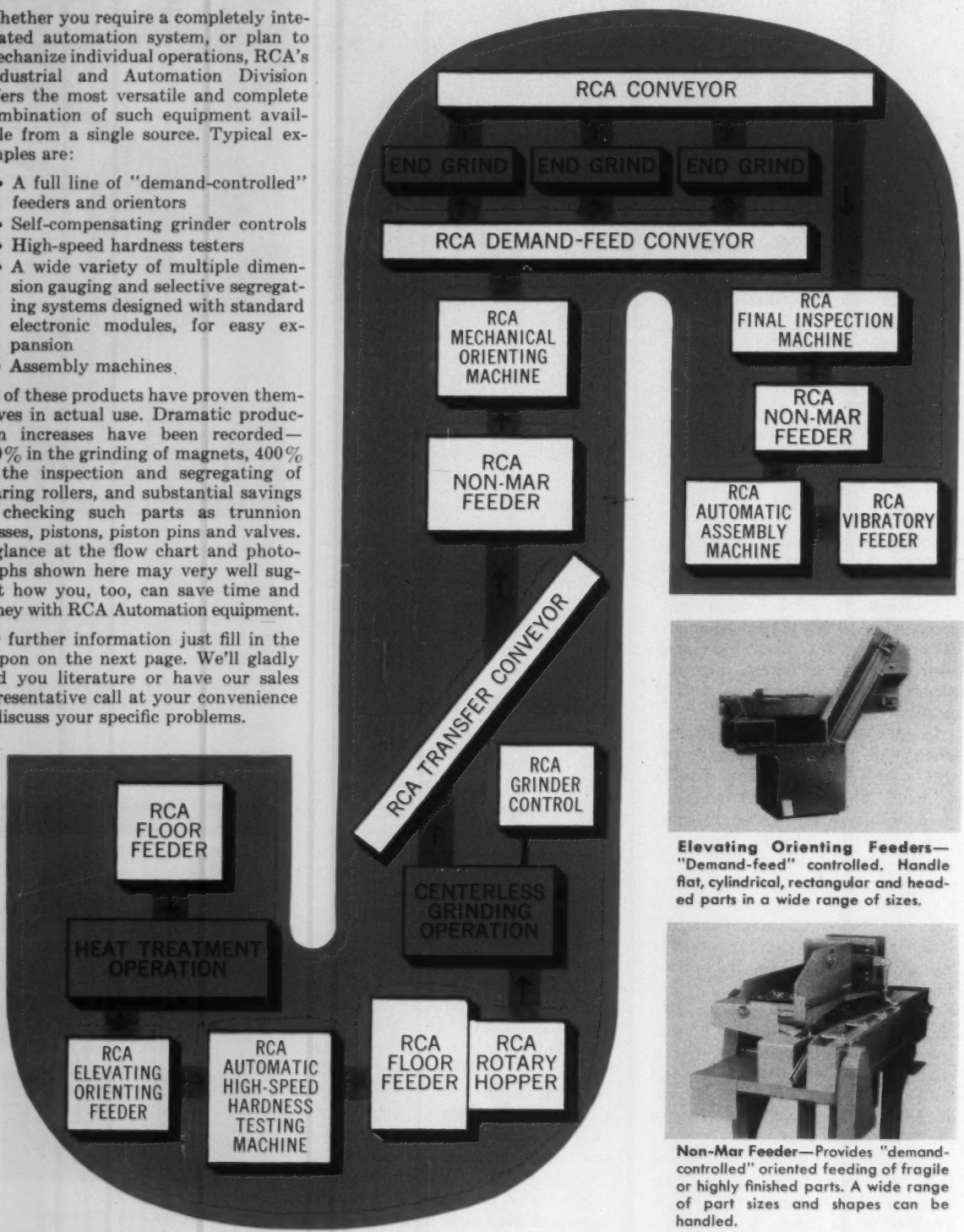
REDUCE COSTS . . . INCREASE PRODUCTION

Whether you require a completely integrated automation system, or plan to mechanize individual operations, RCA's Industrial and Automation Division offers the most versatile and complete combination of such equipment available from a single source. Typical examples are:

- A full line of "demand-controlled" feeders and orientors
- Self-compensating grinder controls
- High-speed hardness testers
- A wide variety of multiple dimension gauging and selective segregating systems designed with standard electronic modules, for easy expansion
- Assembly machines

All of these products have proven themselves in actual use. Dramatic production increases have been recorded—200% in the grinding of magnets, 400% in the inspection and segregating of bearing rollers, and substantial savings in checking such parts as trunnion crosses, pistons, piston pins and valves. A glance at the flow chart and photographs shown here may very well suggest how you, too, can save time and money with RCA Automation equipment.

For further information just fill in the coupon on the next page. We'll gladly send you literature or have our sales representative call at your convenience to discuss your specific problems.

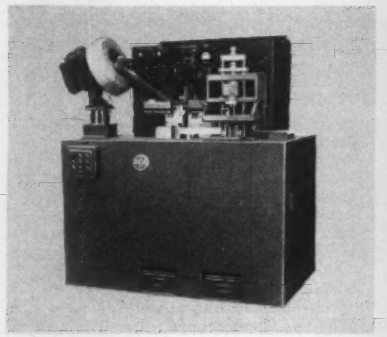


Elevating Orienting Feeders—"Demand-feed" controlled. Handle flat, cylindrical, rectangular and headed parts in a wide range of sizes.

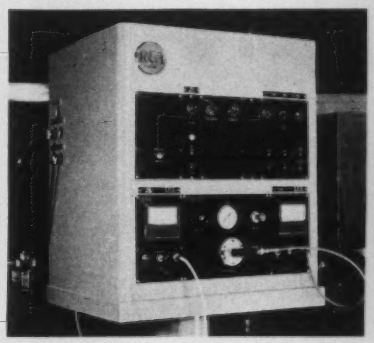
Non-Mar Feeder—Provides "demand-controlled" oriented feeding of fragile or highly finished parts. A wide range of part sizes and shapes can be handled.

BACKED BY YEARS OF EXPERIENCE IN

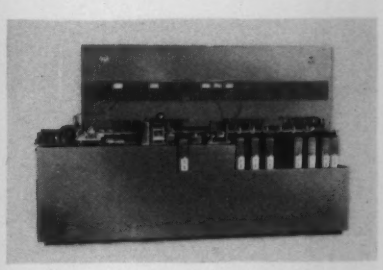
WITH RCA "BUILDING-BLOCK" AUTOMATION



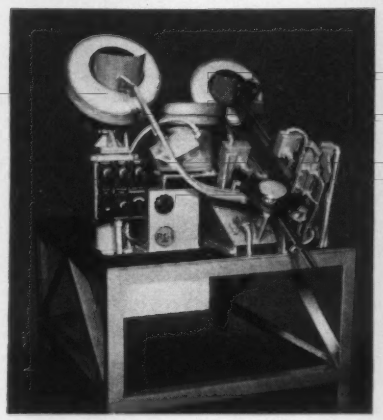
Automatic High-Speed Hardness Testing Machines—Inspect up to 2500 parts per hour with laboratory accuracy.



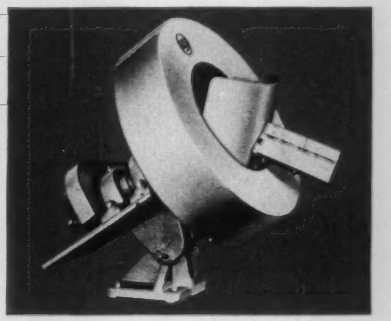
Centerless Grinder Control—Accurate to .000050", RCA self-compensating grinder controls can be used in rough as well as finish operations. Extreme reliability and 100% repeatability are reported by users.



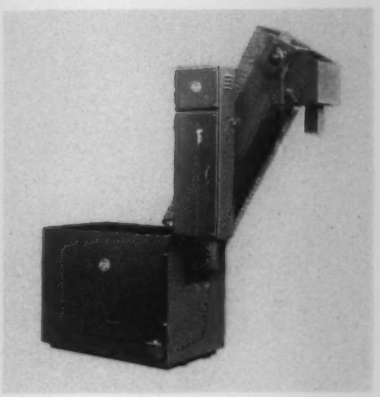
Final Inspection Machines—Equipment similar to the one above, inspect O.D., I.D., length, taper, true roundness. They also provide automatic segregation of inspected parts into almost any desired number of categories, as well as stamping and counting.



Automatic Assembly Machines—This unit automatically assembles bolts and lock washers. It is one of the many assembly machines developed by RCA.



Rotary Hopper—Exceptionally low in cost, RCA rotary hoppers are available with 18", 24", and 30" bowls. RCA orienting discharge tracks for various part sizes and shapes are mounted on the hopper by merely loosening and tightening one screw.



Floor Feeders—High-Speed, "demand-feed" control, broad versatility in parts handled, and large storage capacity make these units ideal for integrating machine operations.

Mail coupon below for further facts

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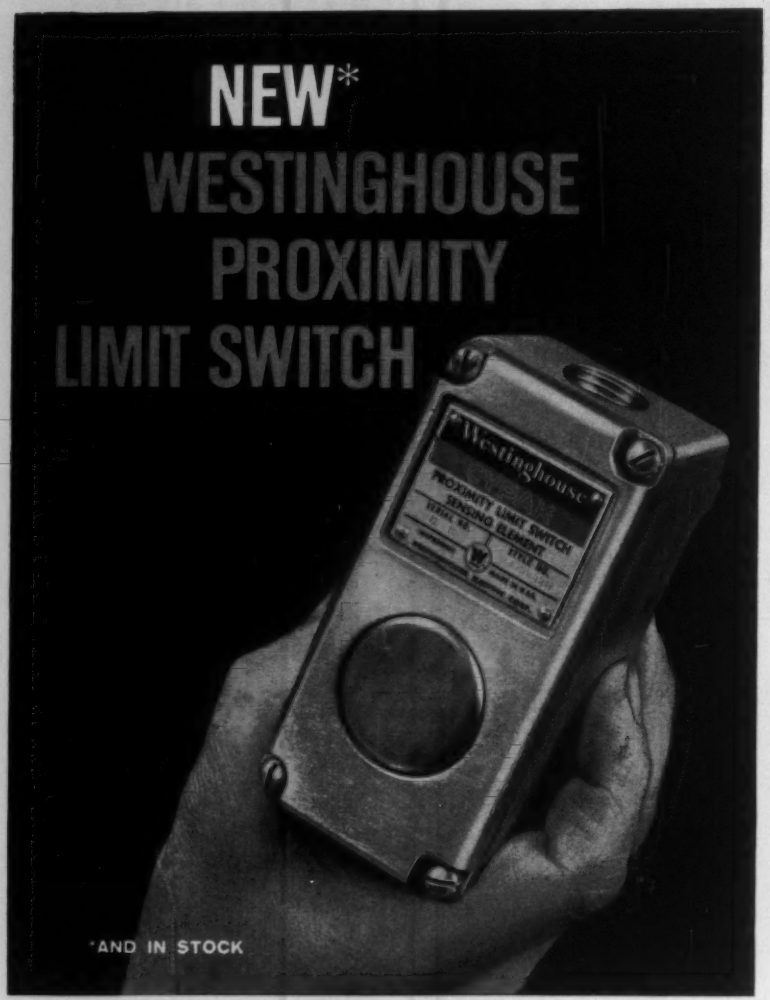

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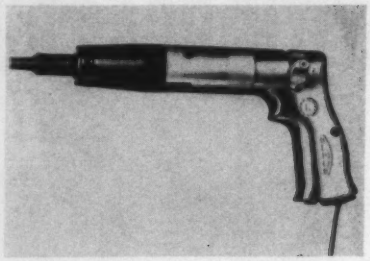
Sure, they cost a little more initially. But we haven't seen the application yet where the new Westinghouse proximity limit switch can't pay for itself time and again through eliminated replacements and machine down time.

GET ALL THE FACTS about new Westinghouse proximity limit switches . . . see how and where they can benefit you. Write to Westinghouse Electric Corporation, Director Systems Department, 356 Collins Avenue, Pittsburgh 6, Pennsylvania. J-01011

YOU CAN BE SURE...IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS



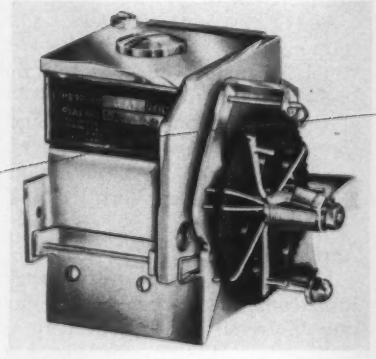
SCREWDRIVER-NUT RUNNER designed by Cleco Air Tools features automatic starting or stopping of an internal air motor. When an operator engages the screw with the finder and bit, the air motor automatically starts. After screw has been tightened to proper torque setting, air motor instantly shuts off. Tool is available with reversible or non-reversible motor and will handle up to ¼-inch free running screws or up to #10 self tapping screws.

ident-manufacturing for B. F. Goodrich Co. . . . **John L. Pfeffer** elected president of National Association of Relay Manufacturers. . . . **Glen R. Pittman** appointed Eastern Operations manager for Modernair Corp. . . . **Merle A. Hayward** appointed vice president of manufacturing for Phillips Control Corp. . . . **Clive M. Yeomans** named head of a new Industrial Automation Div., Victoreen Instrument Co. . . . **Harry C. Soukup** appointed general manager and **Edward F. Woytych** named works manager for the Fond du Lac Div., Giddings & Lewis Machine Tool Co. . . . **Joseph F. Degen** appointed vice president-manufacturing of Daystrom-Weston Division, Daystrom Inc. . . . **Anker G. Christensen** named director of manufacturing for Read Standard Div., Capitol Products Corp. . . . **Bernard J. O'Neill** appointed vice president in charge of engineering at Magnetic Amplifiers Inc. . . . **Frank U. Hayes** appointed president and general manager of Sperry Products Inc. . . . **Albert Musschoot** appointed director of Research and Development for Carrier Conveyor Corp. . . . **Kenneth A. Arata** named manager of Process Engineering for decorative laminated plastics, and **John C. Pitzer** appointed manager of Process Engineering for industrial products at Formica Corp.

SPOTLIGHTING PLANTS

Natfonal Automatic Tool Co. Inc. has purchased Jes-Cal Co., manufacturers of honing tools. . . . **Biever**

Air & Hydraulic Equipment has been appointed representative for Hunt Valve Co. in the Atlanta territory. . . . **Crane & Egert Corp.** is the new name for Kee Enterprises Inc. . . . **Kahle Engineering Co.**, designers and builders of machinery for the electronic and glass working industries, has moved to a new plant in Union City, N. J. . . . **American MonoRail Co.** has entered into an agreement for the purchase of a 130,000 sq ft building in Euclid, Ohio, and expects to be relocated in the new plant by mid-year. . . . **Texas Instruments Inc.** has announced the start of construction on a 192,000 sq ft addition to its present 310,000 sq ft Semiconductor-Components Div. plant in Dallas, Tex. . . . **Consolidated Electrodynamics Corp.** has approved a plan to incorporate its Systems Div. and operate it as a wholly owned subsidiary. The new company will be called the Consolidated Systems Corp. . . . **Automatic Control Co.** has formed a new subsidiary, Autocon Industries Inc., to handle its sales program. . . . **American Radiator & Standard Sanitary Corp.** has formed a new Industrial Div. by consolidating its American Blower, Kewaneee Boiler, and Ross Heat Exchanger Divisions. . . . **Houston In-**



ELECTROMECHANICAL decoder which can be set to respond to any one of 20 million combinations of coded digital pulses has been developed by Secode Corp. The code to which the decoder will respond can be changed without tools in less than one minute. Pulses of dc current cause an electromagnet to drive a notched code wheel one step for each pulse. Response code is set up by placing pins into small holes near the periphery of a 70-tooth code wheel. Positions of the code pins determine the number (1 to 7 digits) or combination of pulses which will cause a pair of electrical contacts to close. The contacts will not close under any other condition.

SELECTROL®
Automatic Checkweigher

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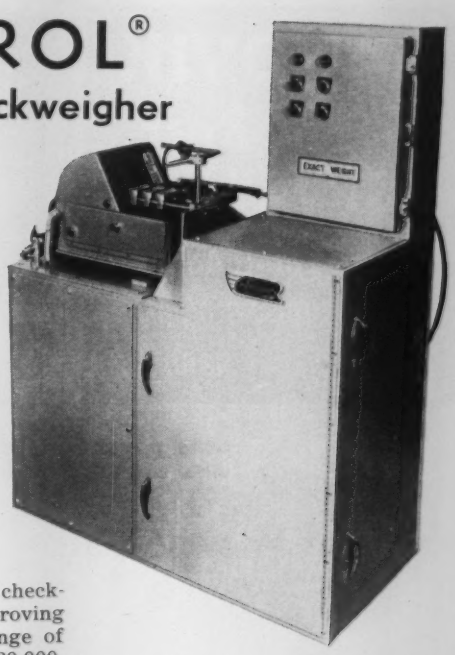
. . . with unvarying accuracy

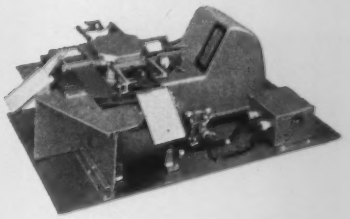


This Selectrol precision checkweigher is capable of proving weight accuracies in the range of 1 part in 5,000 to 1 part in 20,000. Automatic transfer mechanism places commodity on the scale and removes it. Operating speeds up to 60 units per minute depending on capacity and accuracy required.

Selectrol employs a Shadograph, an extremely sensitive scale with a light-projection indication system that provides visual readings. Optional accessories include recording, counting, signaling and control devices.

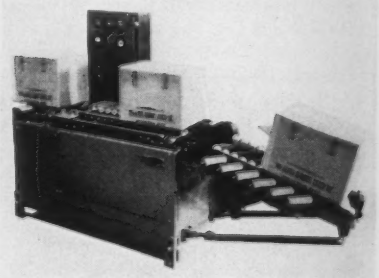
Selectrols are made by Exact Weight, a manufacturer of scales for 45 years and with experience in hundreds of checkweighing installations. Write for Bulletin 3347.

MODEL 145 SELECTROL has in-line "walking deck" type transfer mechanism.



MODEL 144 SELECTROL has rotary transfer mechanism. Automatic selection or rejection is provided immediately following the weigh station.

New Case and Bag Checkweigher



Model 1250 Selectrol, for checking cases, cartons and bags from 20 lbs to 100 lbs., offers accuracy one-tenth-of-one per cent. Speeds up to 30 units per minute. Model shown has over and under weight rejection. Also supplied with underweight rejection only or without rejection mechanism. Optional equipment available for machine control, recording, counting and visible or audible signaling. Write for Form 3280.

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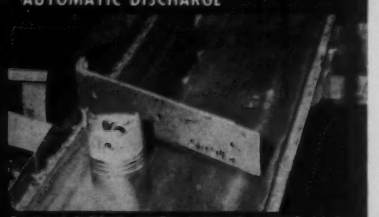

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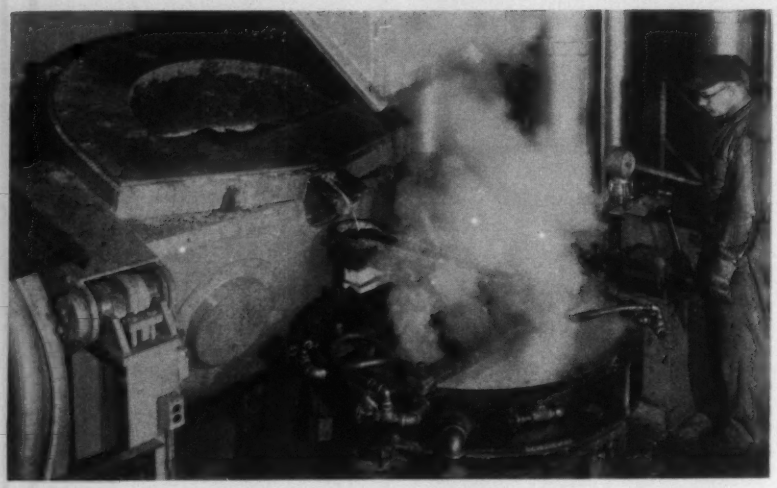

CONTINUOUS casting machine developed by Lobeck Casting Processes Inc. is capable of casting heavy nonferrous metals and alloys in lengths up to 20 feet. Liquid metal flows from an induction furnace spout, along a trough, to a distributor which guides the material into short, water-jacketed molds. The metal cools rapidly as it passes through the "bottomless" molds and is solid by the time it leaves them. The molds are continuously filled with molten metal to match the withdrawal of the solidified castings until ingots have been cast to a desired length. Machines are already in production to produce multiple strand extrusion billets up to 10 inches in diameter and rolling mill slabs up to 6 by 24 inches in cross-section and lengths up to 20 feet.

strument Corp. has been formed for the development, manufacture, and sale of laboratory and specialized industrial instruments for the petroleum and chemical industries.

MEETINGS AND EVENTS

March 17-19—

American Machine Tool Distributors Association. Spring Meeting to be held at the Sheraton Park Hotel, Washington, D. C. Additional information is available from James C. Kelley, AMTDA headquarters, 1900 Arch St., Philadelphia 3, Pa.

March 19-20—

Society of Automotive Engineers. National Production Meeting to be held at Sheraton-Cadillac Hotel, Detroit. Further information may be obtained from John A. C. Warner, SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

March 23-25—

Third Conference On Manufacturing Automation. Co-sponsored by Purdue University and AUTOMATION magazine, conference will be held at Purdue University, Lafayette, Ind. For additional information contact the Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio.

March 29-April 1—

American Society of Mechanical Engineers. Instruments and Regulators Conference to be held at Case Institute of Technology, Cleveland. Additional information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

April 6-10—

American Welding Society. 40th Annual Convention to be held at Hotel Sherman, Chicago, and the Welding Show to be held April 7-9 at the International Amphitheatre, Chicago. Additional information is available from AWS headquarters, 33 W. 39th St., New York 18, N. Y.

April 7-10—

Numerical Control in Industry. Joint conference presented by Purdue University and University of California. Western conference to be held on March 22-25 at University of California Conference Center, Lake Arrowhead, Calif.; and Eastern conference to be held April 7-10 at Memorial Center, Purdue Campus. Further information may be obtained from Div. of Adult Education, Purdue University, Lafayette, Ind.

April 13-15—

American Society of Mechanical Engineers. Hydraulic Div. Confer-

ence to be held at University of Michigan, Ann Arbor, Mich. Additional information is available from ASME headquarters, Meetings Dept., 29 W. 39th St., New York 18, N. Y.

April 13-15—

Life Office Management Association. Automation Forum for users of magnetic tape data processing equipment to be held at the Drake Hotel, Chicago. Further information can be obtained from LOMA headquarters, 110 E. 42nd St., New York 17, N. Y.

April 13-17—

American Management Association. 28th National Packaging Exposition to be held at the International Amphitheatre, Chicago. Additional information is available from AMA headquarters, 1515 Broadway, New York 36, N. Y.

April 14-15—

Armour Research Foundation. Conference on Industrial Instrumentation and Control to be held at Illinois Institute of Technology, Chicago. For further information, contact M. J. Jans, Conference Secretary, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

April 21-23—

American Society of Lubrication Engineers. Annual Meeting to be held at the Statler-Hilton Hotel, Buffalo, N. Y. Additional information is available from ASLE headquarters, 84 E. Randolph St., Chicago 1, Ill.

"Hey Fred, pass me three of those steel balls."

Here it is—

The PAINTING TOOL ALL Industry has been waiting for!

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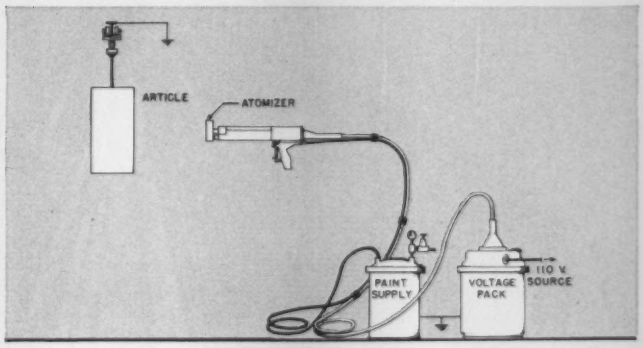

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Saves Labor, Increases Production because it is faster on many types of articles such as those fabricated from perforated and expanded metals, tubing, rod and wire. This is due to the "wrap-around" nature of electro-spray which paints ALL sides of such articles from one side only.

Saves in Equipment because no conventional spray booth is required—no water-wash, no sludge recovery! Uses no compressed air for atomization.

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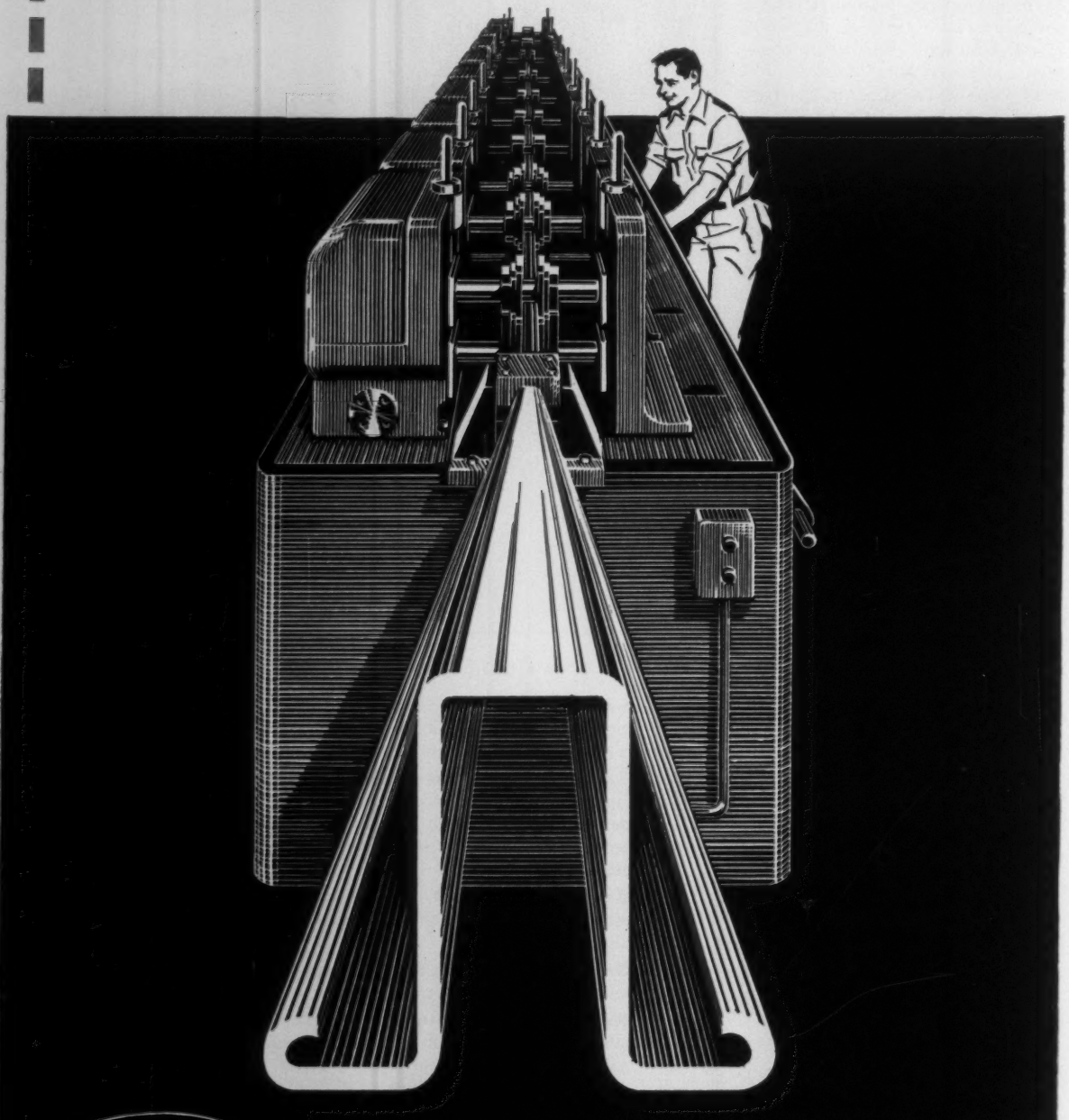
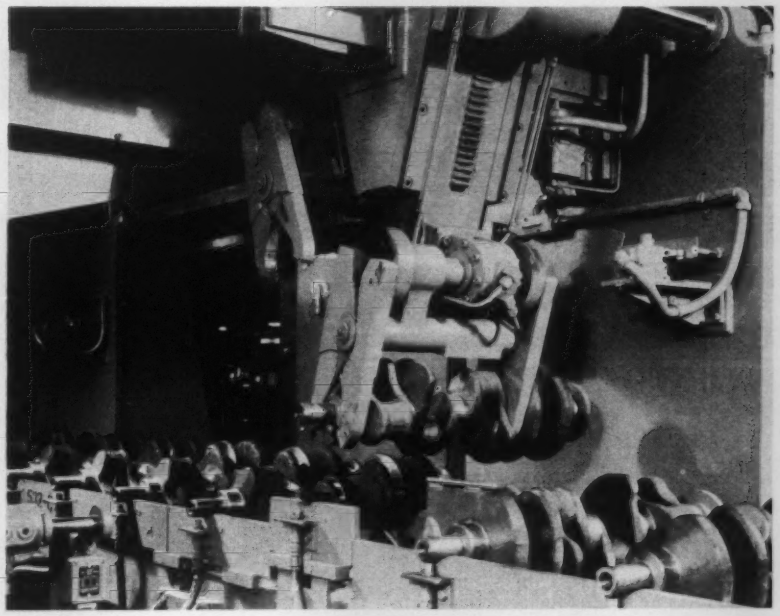


ENGINEERING YODER MANUFACTURING

COLD ROLL FORMING MACHINES

PIPE AND TUBE MILLS (ferrous or non-ferrous)
ROTARY SLITTING LINES

By JAMES C. KEEBLER Managing Editor



Overhead traveling transfer carriage picks crankshaft from shuttle conveyor to transport it to workstation of Wickes lathe in Pontiac engine plant. When carrier, which traverses to the left, arrives at workstation, open fingers (shown at rear in elevated position) will descend and extract previously machined crankshaft from lathe. Then crankshaft to be cut will be placed in lathe and carrier will return to this position and deposit machined shaft on shuttle conveyor.

Comparative Analyses

SCIENTIFIC advancements have repealed many of the old laws of physics. These days a fellow's got to keep an eye on the literature or he will be really out of date.

Legal Eagle

Remembering that old law that for every action there is an equal and opposite reaction, and suspecting that it may be on shaky ground, this columnist proposes the scientific legislators consider a new bill entitled, "The Law of Compensating Disadvantages." This law has its grass roots in the manufacturing plant and has grown out of the unending need for change.

Briefed simply for the purpose of debate the proposal recognizes the scientific truth that when studying manufacturing techniques one soon learns that: . . ."for every advantage there is a compensating disadvantage." The reason this is not called the "Law of Advantages" is in recognition of the popularity of pessimism. The word "equal" is omitted because it doesn't belong.

Engineered Industry

Herein lies the problem. If the advantages are bigger than the disadvantages, best counsel says: "Zag." If not so, then: "Zig." Trying to resolve these weighty problems often plots a long range pattern that looks quite zig-zaggy.

Industrial engineers, who generally answer: "Headaches" to the question: "What do you work on?", should be called as first witnesses at the hearings. Their recent consideration of the merits of "Work Simplification" vs "Job Enlargement" is a case in point. Though much more study of the concepts appears warranted, the gist of the matter seems to be that when the worker's job gets too simple he gets rocky and needs enlarged duties to occupy his mental prowess.

Simultaneous efforts at work simplification and job enlargement may portray the impression that the powers that be are running off in both directions at once, but it must be remembered that the law applies. The best, unified, broad, integrated approach to any problem can be suspect on the same grounds.

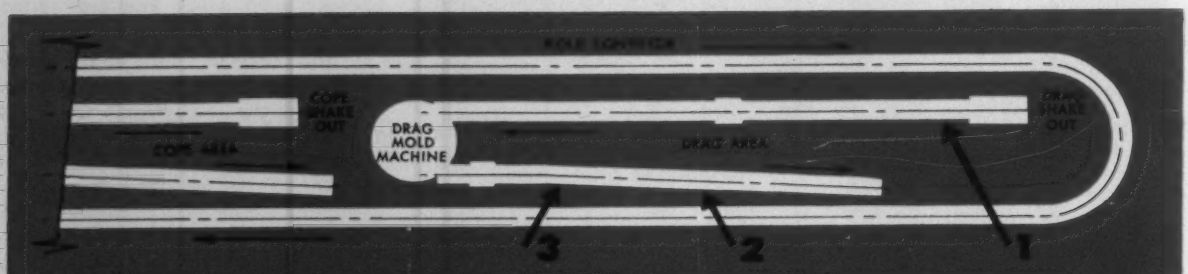
The trend toward monotonous shop work that uses the employee like a mechanism is compensated for by another trend more effective than mere job enlargement—this is automation. This in turn is causing a shortage of direct labor operations to be time studied, simplified and enlarged and thereby forces the industrial engineer to start thinking about the design of production systems.

The influx of industrial engineering talent into the manufacturing engineering function of the automaking business should bring welcomed advantages. Experience gained from analysis of operations should serve as a good foundation on which to build better techniques for the synthesis of automation systems.

Economic Advantage

Cost analysis procedures are one of the industrial engineer's long suits. These techniques must be developed into more useful tools to help design a production arrangement. In comparative analyses it is customary to evaluate the large cost items and ignore the minor expenses in order to simplify the calculations, since the myriad of cost factors involved in operating a modern plant prohibit minute summaries for each proposed alternative. As direct labor content decreases other factors assume more predominant proportions. In the extreme case the choice between two processes, neither of which involves any direct labor, certainly must be

ANCHOR'S NEW ENGINEERING CAN MEAN IMPORTANT



TYPICAL ANCHOR FLASK HANDLING AUTOMATION

FEATURES

ANCHOR flask handling automation is rugged, resulting in low maintenance costs.

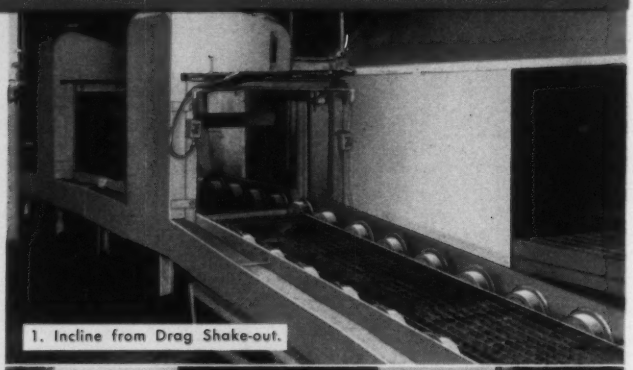
Provides a float of empty flasks and completed molds, increasing flexibility of the mold system and making it less vulnerable to temporary shutdowns.

Has ability to index one unit at a time, as required, with less damage to molds.

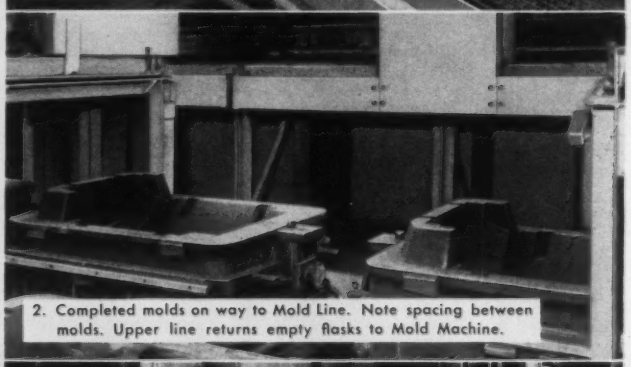
Affords excellent traction and flask may be transported up inclines or down declines.

Rubber tired wheels are an improvement over other handling methods.

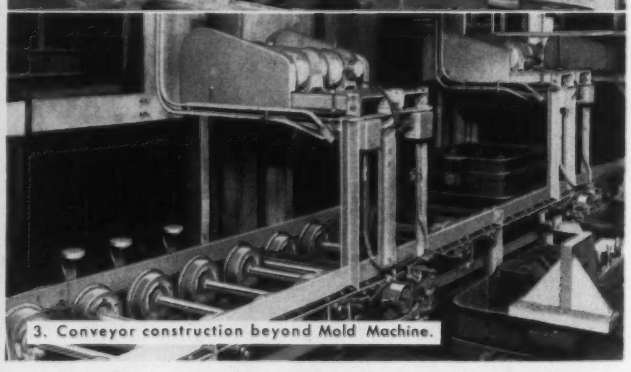
This type of equipment is adaptable to automatic, semi-automatic, and manual systems.



1. Incline from Drag Shake-out.



2. Completed molds on way to Mold Line. Note spacing between molds. Upper line returns empty flasks to Mold Machine.



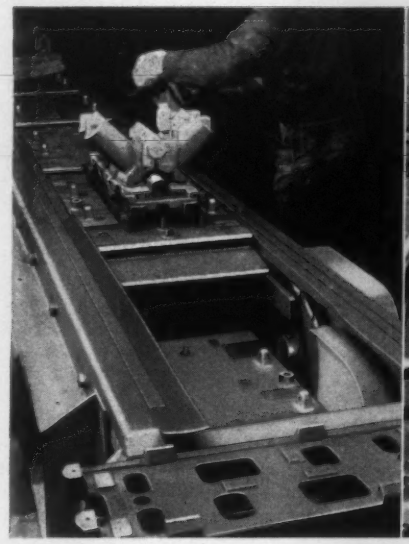
3. Conveyor construction beyond Mold Machine.

CONCEPTS IN FOUNDRY CONVEYORS SAVINGS TO YOU . . .

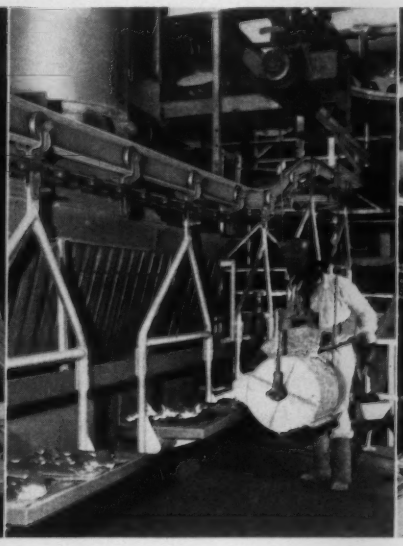
When difficult handling problems have arisen in the foundry industry, *Anchor Steel and Conveyor Company* has been called in to apply imaginative engineering to arrive at a proper solution.

The result has been some very interesting new developments that provide greater efficiency in foundry operation.

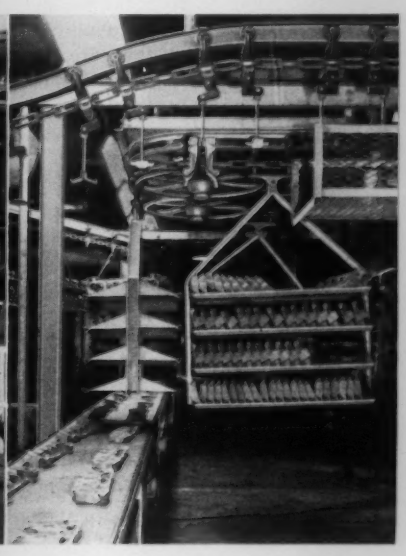
If you have such problems in your foundry may we suggest that you too avail yourself of Anchor's wide experience in solving the most difficult handling problems.



ANCHOR UPRIGHT RETURN PALLET CONVEYOR applied to Core Assembly. Conveyor pallet always remains level and returns in the upright position. Pallet drops away from core plate on discharge end, depositing it on anti-friction rollers for transportation to next operation.



ANCHOR 6" OVERHEAD TROLLEY CONVEYOR used in the Shell Mold Process. View shows the pouring station. Conveyor is equipped with Lubricated-for-Life trolleys.



TYPICAL 4" ANCHOR OVERHEAD CONVEYOR used through Core Drying Oven. The trolley seals are omitted and the bearings are flushed and spray lubricated after every cycle.

ANCHOR designs, manufactures and installs many types of custom engineered Conveyors, including Overhead Trolley, Power and Free, Slat Conveyors, "Tow-All" Conveyors, Belt Conveyors, Turntables, Pallet Conveyors, Storage and Assembly Conveyors, and others.

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Circle 669 on Page 17

made on the basis of other criteria.

This suggests that we may see the day when the manufacturing engineer who plans a new line will need to calculate electrical power consumption per unit of production so that his proposal can be compared with others on this basis.

It suggests also that the mere technical feasibility of doing the job automatically and the comparison of cost with a manual method are not the sole yardsticks for measuring automation. In the last analysis—the corporate blance sheet—the automation method that leaves the most money in the till when all the charges are made and all the bills are paid, is the best method. Ingenious automatic machinery, marvelous combinations of old tried and new found ideas, all necessary ingredients for the successful system, achieve success not on the basis of how automatic or how new or startling they are, but how successfully they are applied for the corporate purpose.

Crankshaft Know-How

An interesting trend to watch is the long-term development of crankshaft manufacturing techniques. Forged steel, cast iron, shell molded nodular iron, and modified cast steel materials all have compensating disadvantages. Machining processes vary with material and manufacturer, but certain equipment types are used almost universally. Among these is the crankpin lathe.

Automation is inherent in this classic design that is 30 years old. As a crankshaft is rotated about the axis of its main bearings, tool slides at each of the crank positions follow their respective crankpins in orbit about the center of rotation. The cutting tools are advanced to the proper depth of cut and retracted, machining all crankpins simultaneously. Automatic cycling is combined with automatic load-unload mechanisms to provide a high degree of automation.

New Layout

The crankpin lathe setup at Pontiac's engine plant represents a departure from this tradition. Instead of machining all crankpins simultaneously in one lathe, this arrangement has a lathe for each and cuts one at a time. Each machine spins the workpiece about the axis of the pin it is cutting and has a front and rear tool slide with only simple in-out action—no orbiting. To complete all four crankpins, each crankshaft must go to four such lathes. Transfer between lathes is accomplished automatically during cycle time of the cutting actions and therefore does not increase the over-all production time.

Reasons Why

Whereas the rules of work simplification suggest that operations be combined where possible, this development seems to go counter to the book by breaking the classic crankpin machine down into separate operations.

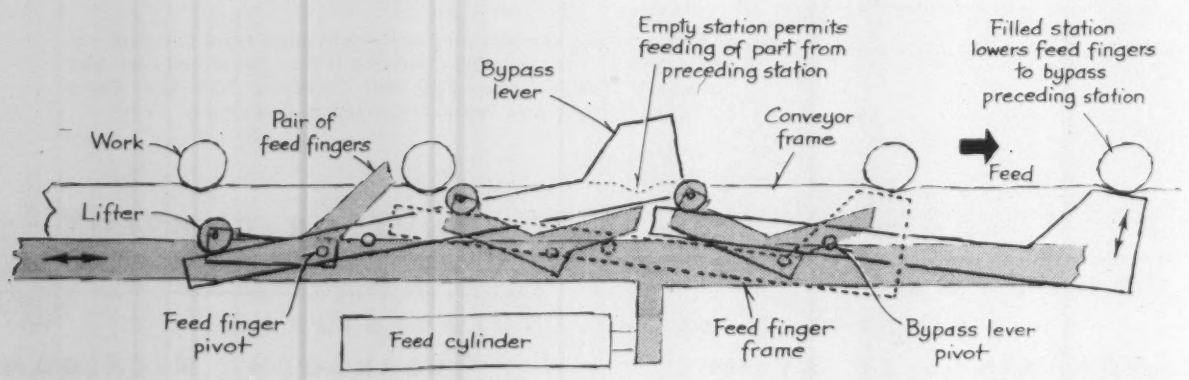
Pontiac's Tom Seavey, master mechanic in charge of these matters, indicates some of the advantages considered in the thinking that went into the decision to procure this line. 1. Without large tool slides going around with the workpiece the turning speeds can be greater and the advantages of carbide tools can be realized. 2. Setup is simplified such that tool change time is reduced. 3. Similarly, retooling for crankshafts of different dimensions can be accomplished by changing inserts in the chucks and providing new cutting tools rather than by rebuilding major portions of the machine. 4. Increased rigidity in holding the crankshaft increases dimensional accuracy of the machining operation. 5. Increased production rate per dollar invested in capital equipment.

The biggest disadvantage at the planning stage was the consideration that although the concept had been successfully applied to other workpieces it was new to crankshafts. Pontiac hedged this risk with the stipulation that the equipment had to be built by a "crankshaft machine builder."

There's not a great amount of difference between these methods on a simple comparison of direct labor, but there's a lot more to this automation business than direct labor comparisons.

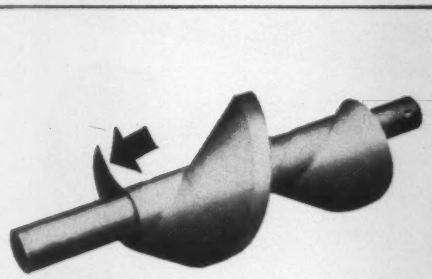
Pontiac is happy with the new arrangement. It will be interesting to note the effects of this type of analysis on the long term trends of the industry.

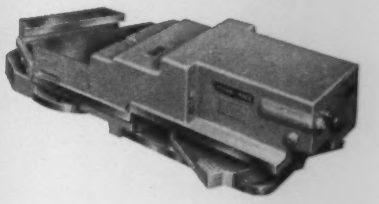
Shuttle conveyor connects pickup points of overhead transfer carriages which serve each lathe in the crankpin line. Sections between machines act as storage banks, permitting uninterrupted production on remaining machines while one is down for scheduled tool change. Feed finger frame reciprocates ten times as often as the carriage so that the first workpiece to enter an empty bank section will go right through the bank as it would if this were a loading chute. This feature allows tool change downtime on all four machines for the price of one, rather than accumulative as would otherwise be the case. Bypass lever arrangement permits feed finger to advance a workpiece only in the event that the station ahead of it is vacant.



New turning idea is born...

LeBlond Engineers turn trick with tracer

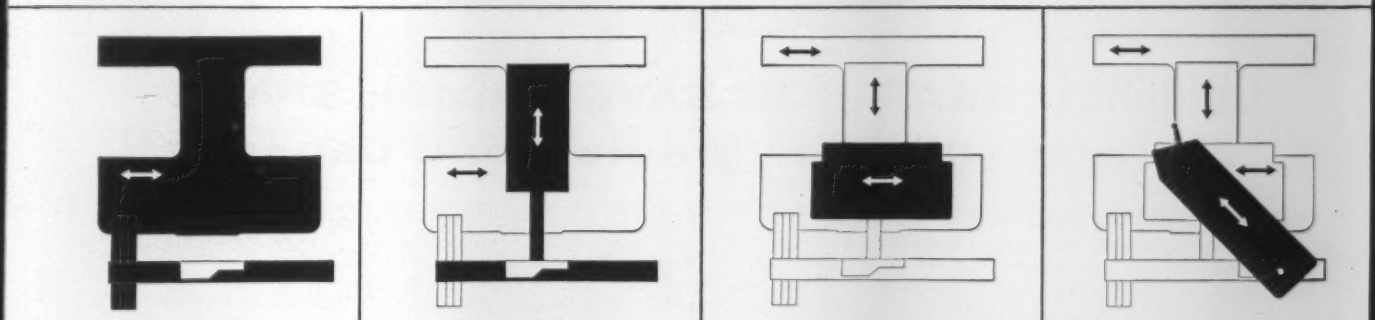




1. Problem workpiece—spiral rotor for pumps manufactured by Roots-Connersville Blower Co., Connersville, Indiana. Shaping just couldn't produce the wide variety of exact contours their engineers wanted. Could rotors be *turned*—automatically?

2. Why not? With special end gearing and full nut, we can "chase" the spiral shape like a coarse thread. That's easy . . . the problem is the contour.

3. We'll use Hydra-Trace to *position* the tool (not to trace). We can mount a special length slide on the cross slide to give us feed *between* cuts.

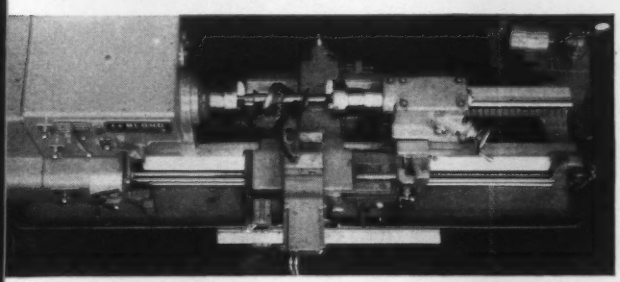


4. Let's see how this looks in plan. The carriage provides length motion for the tool. The template carrier moves lengthwise with the carriage.

5. The cross slide gives cross travel plus automatic tool relief. The template carrier also moves "in and out" with the cross slide.

6. The special length slide gives us feed. Not continuous feed. Just tool-positioning feed that moves the stylus along the template for each successive cut.

7. The template controlled Hydra-Trace positions the tool to produce the contour. During the cut, no feed takes place. Only the chasing action.



8. Here's the finished machine—the LeBlond Contour Chasing Lathe, basically a 32″ Standard Duty. Modifications include: special end gearing, full nut, special length slide, automatic cycling and special heavy duty reversing electrics. Lathe chases leads from 4½″ to 16″.

. . . cut with confidence

The R. K. LeBlond Machine Tool Company

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We welcome the opportunity to solve your special turning problems. Tell us about them. Call or write for an engineering appointment.

World's Largest Builder of A Complete Line of Lathes for More Than 71 Years

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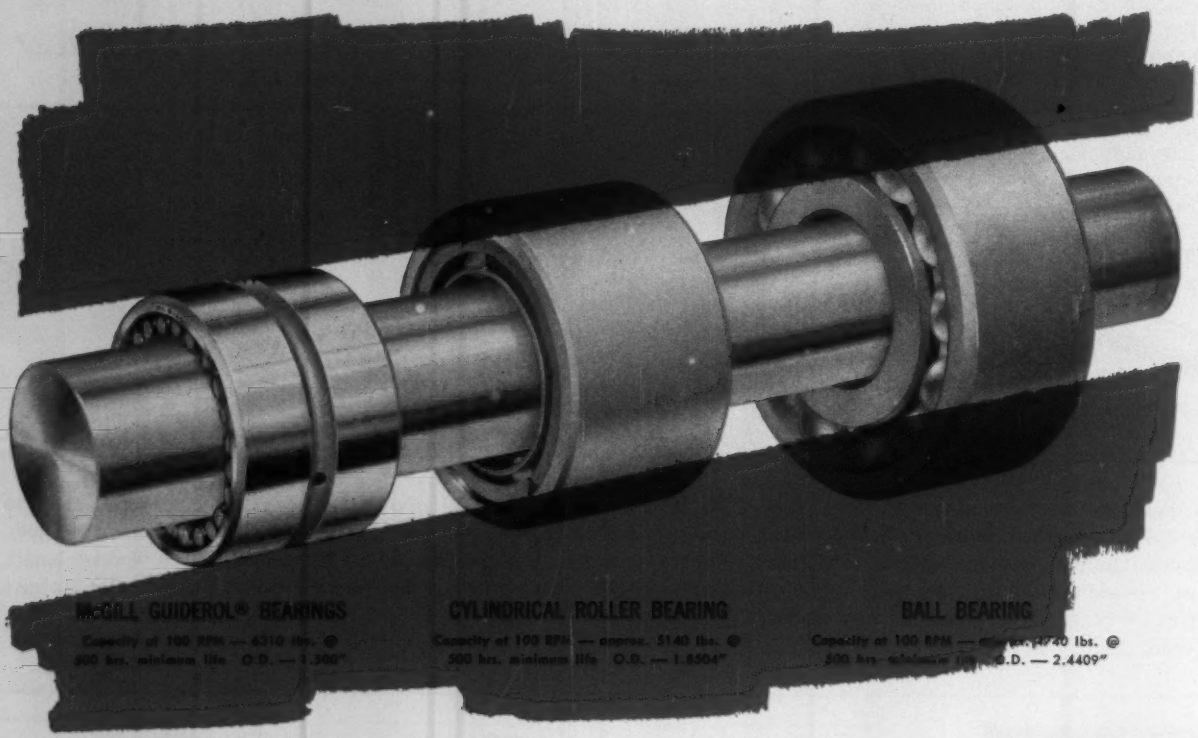
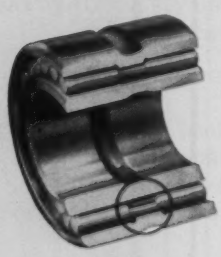


GUIDEROL® BEARINGS SAVE RADIAL SPACE

.....and still offer greater load capacity

This graphic illustration demonstrates the radial space saving advantages of McGill GUIDEROL bearings that offer still greater capacity than the other two types of bearing compared. For a common 1" shaft, the GUIDEROL bearing GR-16 has an O.D. of only 1½" with a capacity of 6310 lbs. Compared to a cylindrical type roller bearing the GUIDEROL bearing requires ⅜" less housing space and offers 23% more capacity. A ball bearing for the same shaft uses almost an inch larger O.D. to carry 1500 lbs. less radial load.

CENTER GUIDED ROLLERS



GUIDEROL bearings pack more performance into smaller radial space. Their construction offers the inherent high capacity of a full complement needle bearing combined with effective roller control. Center guided rollers limit roller skewing tendencies and prevent binding under adverse conditions in either horizontal or vertical mountings. This qualifies GUIDEROL bearings for applications which are too heavily loaded for retainer type needle bearings, but are subject to misalignment that precludes the use of unguided needle bearings. Standard GR series GUIDEROL bearings are available, with or without inners, in shaft sizes from ⅝" to 9¼" with capacities ranging from 2880 lbs. to 128,670 lbs. (at 100 RPM).

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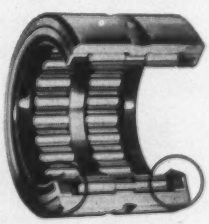

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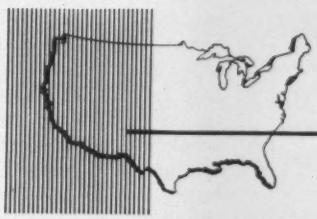
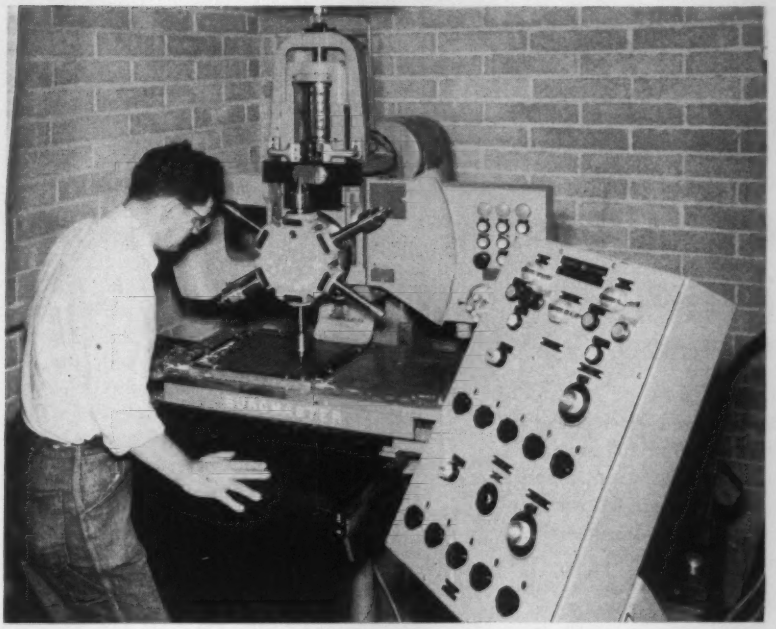


western trends

By PATT PATTERSON
Los Angeles, Calif.



Operator supervises automatic turret drill located in a darkroom at General Electric Co.'s Computer Department. The six-spindle Burgmaster drill is directed by punched tape control equipment built by General Electric. Capable of automatically drilling 15 to 20 holes a minute in a circuit board, the machine also includes a light attachment that automatically traces out circuit lines on the sensitized board surface prior to an etching operation.

Holes to Order

IN the "good old days" when automation was mainly concerned with eliminating manual transfer, with positioning, and with Off-On control of a series of machines, the computer was a vast, unreal "giant brain" with no relation to production. These huge electronic devices were used for outguessing the voters, for scientific laboratory work, and for predicting the number of shoes required by the Army.

Today, however, computers have moved into every phase of industry. In the front office, computers are used to forecast sales, based on known statistics and upon estimates of the future. Payrolls and accounts are automatically figured by computer, and supply inventories are maintained by a computer.

In production, computers have taken a significant place. In some plants, machine tools are operated by tape or card controls—and these controls are programmed by computers.

In the West, this use of computers is particularly prevalent. Although the giant brains of yesterday were developed elsewhere, a good many of the smaller descendents of those units are manufactured in Southern California. The Royal Precision LGP-30, designed and manufactured by Librascope, Glendale, Calif.; the Libratrol 500, a newly introduced process control computer designed by the same firm; the RW-300, a process control computer built by Thompson-Ramo-Wooldridge Products Co. of Los Angeles; and a number of other analog and digital computers are built in the West.

General Electric Co.'s Computer Department in Phoenix, Ariz. employs automatic equipment to build computers and computers to control the automatic equipment. A good example of this double process is in printed circuit board construction.

These boards are produced by using an automatic tape controlled six-spindle turret drill manufactured by Burg Tool Manufacturing Co., Gardena, Calif. The machine automatically positions its worktable on two axes and carries out a predetermined sequence of operations. At the Phoenix plant, 124 different etched copper circuit boards are produced. Some boards have as many as 2400 holes of three different sizes, which are automatically drilled by the hydraulic turret machine. The combination of electronic and hydraulic controls produces automatically drilled boards with an accuracy of ± 0.002 inch between holes. All operations are carried out automatically from a punched tape, and drilling is at the rate of approximately 15-20 holes per minute. The operator loads work into the machine and changes drills when necessary.

One of the major advantages of the Burgmaster unit is the ease with which setups can be made. The only fixtures for the boards are dowel pins on the table. Drill bushings are eliminated. The turret drill has preselective spindle speeds and infinitely variable feeds. Features of the control include skip indexing, which permits a desired sequence of operations; an adjustable rapid approach and return; and adjustable depth control for each spindle.

The drilling equipment is installed in an air-conditioned darkroom where it is used, with a special at-

To Senior Computer Programmers interested in

Research and Development

on advanced

Programming Techniques

Those interested in performing research and development on advanced programming techniques will find full scope for their ability at System Development Corporation in Santa Monica, California. SDC's projects are concerned primarily with developing large-scale, computer-centered systems in a number of fields. The application of advanced digital computer techniques is particularly important in these systems.

As these systems are computer-based, programming is an essential function at SDC. *Programming is not a service activity at SDC.*

A few positions are open for senior Computer Programmers. The positions call for strong experience and ability in programming and keen interest in:

Mechanical and programmed techniques of retrieval—Logical design of computers from a Programmer's point of view—Pattern recognition and machine learning—Language translation (both natural and computer-oriented languages).

Those who desire additional information are invited to contact William Keefer at System Development Corporation, 2498 Colorado Avenue, Santa Monica, California.

SDC

SYSTEM DEVELOPMENT CORPORATION

Santa Monica, California

11-90B

tachment, for exposing the sensitized board surface as well as drilling the holes in the boards. Under punched tape control, it automatically drills the holes in the board. Then, with a light source mounted in one of the spindles, it exposes the circuit lines on the negatively coated board. This operation is also controlled by punched tape which was computer programmed.

Control in Power Generation

If you have ever wondered what happened to the flickering and fading that used to plague the electric lighting in the '30s, the answer is that automation has smoothed out those line variations that used to make power an uncertainty. Automatic devices control line fluctuations and frequency from the power source to the distribution station.

A good example of this control is found in the special automatic equipment designed for the new Kings River hydroelectric development in Central California.

The starting sequence for the giant unit is completely automatic. It requires only a starting impulse that energizes the master control relay, which controls and initiates the following steps:

First, the turbine spiral distributor fills with water to equalize pressure across the turbine valve. The main turbine valve opens when the pressure is equalized. The turbine nozzles open slightly to start the unit turning under governor control. As the governor comes up to speed, its voltage builds up and is controlled by a voltage regulator. A speed matcher relay synchronizes the generator frequency with that of the transmission line. This is done with a series of impulses which set the governor. When the generator is synchronized properly, a circuit breaker closes and connects the generator into the transmission system. Where there are two generators in a plant, the units will be synchronized individually in sequence.

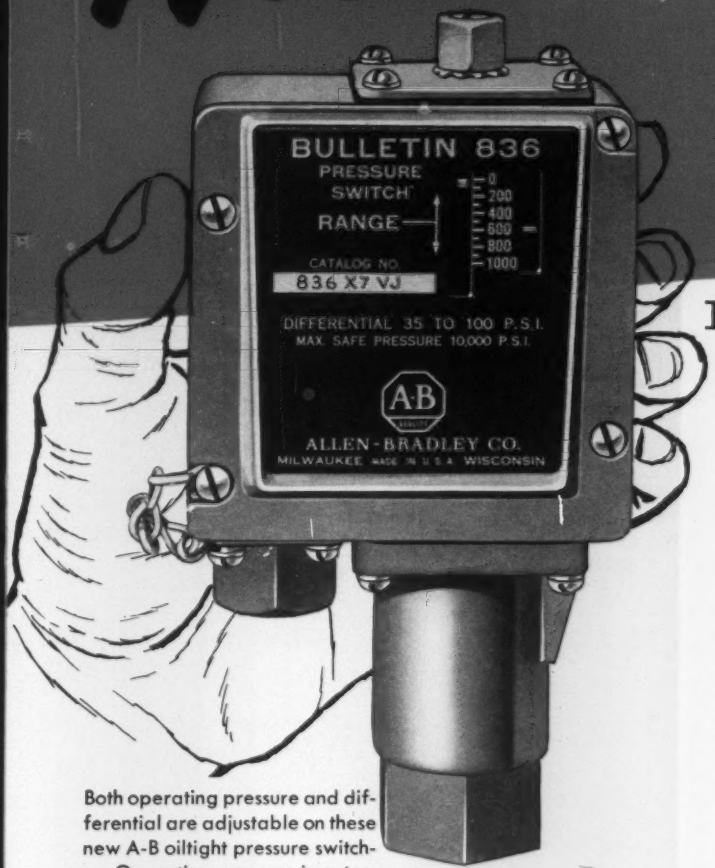
There are a number of devices which will automatically shut down the generators if malfunctions or other abnormalities occur. Some of these simply warn the operator. Others remove the generator (still running) from the line by tripping a circuit breaker. Another set causes a complete shutdown of the generator itself.

Circle 672 on Page 17

Circle 673 on Page 17→

New ALLEN-BRADLEY OILTIGHT PRESSURE SWITCHES

Bulletin 836 Type T



Both operating pressure and differential are adjustable on these new A-B oiltight pressure switches. Operating pressure is externally adjustable, and setting shows on calibrated scale. A trip indicator shows operating point.

For machine tool hydraulic systems—operating at pressures up to 5,000 psi

Especially designed for heavy duty industrial applications, these new Allen-Bradley oiltight high pressure switches assure long, trouble free life. The attractive die-cast aluminum enclosure is completely sealed to exclude oil and water. The snap-action switch mechanism maintains its high contact pressure to the point of switchover—no matter how slowly it is approached. Contact chatter is eliminated—trouble free contact life is increased. The contact block has two isolated circuits with one N.O. and one N.C. set of contacts.

Send for complete information on this newest addition to Allen-Bradley's wide line of *quality* pilot controls.

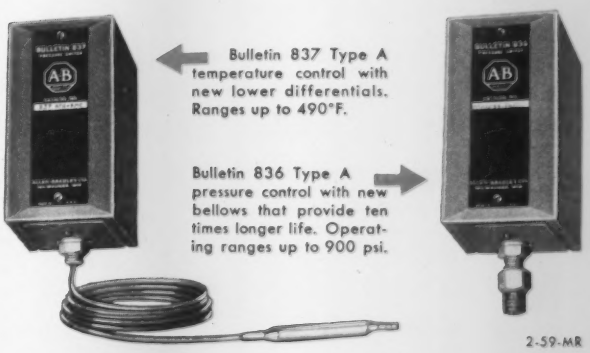
Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY
MOTOR CONTROL
QUALITY

A-B QUALITY

Internal view of piston design used on units for systems above 500 psi. Bellows type construction is used up to 500 psi.

Also...A New Line of Pressure and Temperature Controls with Lower Differentials



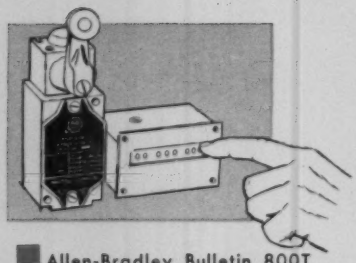
Bulletin 837 Type A temperature control with new lower differentials. Ranges up to 490°F.

Bulletin 836 Type A pressure control with new bellows that provide ten times longer life. Operating ranges up to 900 psi.

2-59-MR

Allen-Bradley is not satisfied until Limit Switch Life runs into

MANY MILLIONS OF OPERATIONS



Allen-Bradley Bulletin 800T oiltight limit switches on typical life tests have run many millions of operations. Write for complete information on the Allen-Bradley line of quality limit switches for every industrial application.

Here are some new—and some old—Allen-Bradley oiltight limit switches—all built to give you extra millions of trouble free operations. Their switch bodies and operating heads are both sealed. Oil, dirt, and metal chips cannot enter and foul the contacts or cause sluggish operation of the momentary contact mechanism. Double break, silver alloy contacts never need maintenance. The snap action switch is positive insurance against any reduction of the contact pressure as the "trip point" is approached. This means less chance for chatter and arcing of relays, contactors, or starters operated by the limit switch—and prolonged trouble free contact life for the limit switch itself.

The Allen-Bradley line of limit switches is complete. Illustrated are only a few variations.

Side Push Rod
Top Push Rod with Plastic Window
Roller Lever for Flush Mounting
Neutral Position Momentary Contact Limit Switch. One set of contacts is closed for each direction of operation.
Adjustable Rod
Adjustable Roller Lever
Wobble Stick Type
Fork Lever Type
Side Push Roller
Roller Lever for Manifold Mounting
Side Push Rod Maintained Contact

2-59-MR

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Don't Miss It

The gradual change into the era of automated manufacturing with full understanding and use of its inherent advantages has only begun. From the vantage point of today's industrial scene, there is much yet to be learned, much to be understood in practical application of the fundamentals so far revealed by dint of laborious trial and error.

Present limits of technological knowledge and know-how indicate the need for considerable research and study to maintain a desirable rate of progress. At a recent ISA meeting in Akron, James E. Trainer, executive vice president of Firestone Tire & Rubber Co., clearly documented the situation with these words:

"The apparent widespread belief, outside the professions responsible for automation, that everything has been accomplished is ridiculous in view of the facts. The field is so big, the possibilities are so great, that even to contemplate the end at this time is to deny the beginning—and that is where we are now."

To cope with the challenge of the coming decade, manufacturers must seriously study the evolving techniques and accomplishments of automation technology. Automation, to be successful, presupposes basic knowledge of all modern processes—it makes imperative the engineering of the manufacturing sequence on a level more sophisticated than that practiced in the past. It raises a compelling necessity for intercommunication between manufacturing executives of all industries and broad study of developments on a continuing basis.

To provide a means for this intercommunication and study, AUTOMATION and Purdue University have instituted a continuing series of conferences. *The Third Conference on Manufacturing Automation* convenes at Purdue on March 23. Here again, key executives will gather at this common meeting place to study and crossbreed ideas for advancing application of automation.

The field *is* big and the possibilities *are* great—here is the opportunity to keep up with these fast-moving developments. Don't miss it.

EDITOR

AUTOMATION

. . . perhaps the area of greatest difficulty has been in training maintenance personnel in the intricacies of tape handling equipment . . .

When numerically controlled machine tools were first introduced to industry, some critics predicted that maintenance of the equipment would completely overshadow the advantages to be realized. Now, with many months of operating experience behind them, aircraft manufacturers have affirmed that maintenance does require special attention, but that familiarization with the equipment has reduced the problem to one of routine operation.

MAINTAINING NUMERICALLY CONTROLLED MACHINE TOOLS

By **JOHN O. MORIN**, Staff Engineer, Concord Control Inc., Boston, Mass.

NUMERICALLY CONTROLLED machine tools are being used throughout industry in increasing numbers. This is particularly true in the aircraft industry where some 170 pieces of equipment—skin mills and profilers, riveters, drilling machines, and punch presses—are in operation in aircraft plants from coast to coast. However, with the advent of numerically controlled machine tools, management was faced with a new type of maintenance problem since these tools are substantially different from the conventional machines previously used. The electrical circuits for the new type machine tools represent a radical departure from the design of ordinary industrial electrical controls. Some of the circuits are very complex indeed, and it is interesting to analyze the problems that have been experienced by various aircraft manufacturers in organizing and programming maintenance for the equipment.

Training Maintenance Personnel

Perhaps the area of greatest difficulty has been in training maintenance personnel in the intricacies of tape handling equipment. This is by far the most complex of the electronic control gear used on numerically controlled machine tools. Unless the maintenance department has had previous experience with similar equipment, such as computers, tape

handling equipment represents a completely different type of device from that to which they have been accustomed.

In establishing a maintenance program, most aircraft companies have started by sending certain selected personnel to outside schools conducted by the equipment manufacturers. Some companies have sent supervising engineers to the schools while other manufacturers have allowed the foreman actually responsible for maintaining the equipment to attend the courses. Whichever method has been used, the specially trained personnel then are required to train their own inplant personnel.

How well the supervising engineer versus the foreman training approach has worked out is subject to some debate. Convair-San Diego started its program by first training the foreman and feels that its approach is justified. Boeing Airplane Co. also has used the same approach and is of the same opinion. In the final analysis, it probably boils down to the personnel themselves: Who is the better teacher and is able to pass along the information he accumulates in the most easily understood manner? This much is certain: The inplant training program must be a formal one and must be supplemented by on-the-job training. When the equipment goes down, there is not sufficient time for an experienced man to pass along all the necessary information to a trainee. In short, formal as well as on-the-job training is recommended.

▶ Diagnosing Trouble

In general, the problem of maintaining numerically controlled equipment has not been the inability of personnel to repair the machine, but rather the problem of quickly locating the point where the trouble occurred. To overcome this difficulty, maintenance "tell tales" of various types have been developed. Some have taken the shape of standard waveforms which, when compared with oscilloscope patterns from various phase outputs of the machine tool control or tape preparation director, enable personnel to determine if operation is normal. Others are in the form of standard test tapes which can be used to compare the results being obtained with those that should be obtained. In this way, the point of deviation or breakdown can be determined more rapidly. These checking tapes are kept on file in an air conditioned, humidity-controlled facility and are made available at any time to the maintenance department.

With but one or two exceptions, the type of failure that has been experienced with tape handling equipment and with the machine tools themselves has been random in character. Naturally, drift in electronic tube characteristics and burnout of tubes are the causes of some equipment downtime, but the frequency of this type of problem has been less than expected. Some companies have experienced tape tracking problems with tape handling equipment, either with the tape preparation equipment or in the machine tool.

Of all the failures that have occurred, the most annoying is the intermittent type which occasionally is experienced in complex electronic gear. While a fault of this type may appear either days or weeks apart, it should be found and corrected as soon as possible. In order to isolate these intermittent troubles, as well as others that are particularly difficult to locate, most of the aircraft companies assign engineering personnel on a part time basis to back up the maintenance department. Generally, one man, either from the plant engineering group or from the maintenance supervisory staff, is made

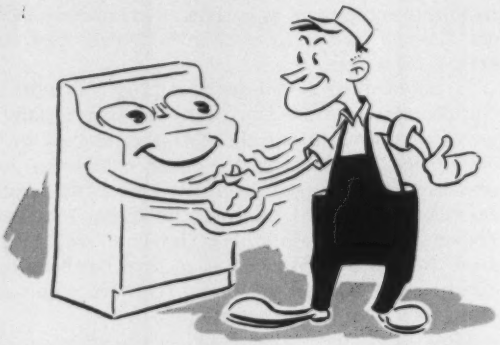
Fig. 1—Typical of the tape preparation equipment used by the aircraft industry is this Numericord director built by Concord Controls Inc. under contract to Giddings & Lewis Machine Tool Co. The unit shown is installed in the Wichita plant of Boeing Airplane Co. where it is used to produce magnetic tapes for numerically controlled machine tools. In addition to processing tape for all of Boeing's divisions, the Wichita installation has also made tapes for other aircraft companies such as North American, Convair, Martin, and Lockheed.

available on each shift. If not needed, the man performs his regular duties; when a fault occurs, he is immediately available to try to isolate the trouble.

Preventive Maintenance

A good rule to follow with any type of numerically controlled equipment is to "let well enough alone." Naturally, if a phase check indicates component drifting, the reason should be determined and the faulty components replaced. However, removing a panel to check contacts, or unplugging other components to check their condition is not recommended as a preventive maintenance procedure since such actions may loosen a connection that will be difficult to find. In short, over-maintenance can be as bad as no maintenance at all.

This does not mean that some preventive maintenance is not required. Sound preventive maintenance programs are in effect at all aircraft plants employing numerically controlled machine tools. Many follow the procedure adopted at the Wichita plant of Boeing Airplane Co. The tape control unit is turned over to the electrical maintenance group for preventive checks whenever loads are light. Personnel check for weak tubes, loose connections, and tracking and tension difficulties in the tape by running check programs. Many potential sources of trouble can be eliminated by this procedure.

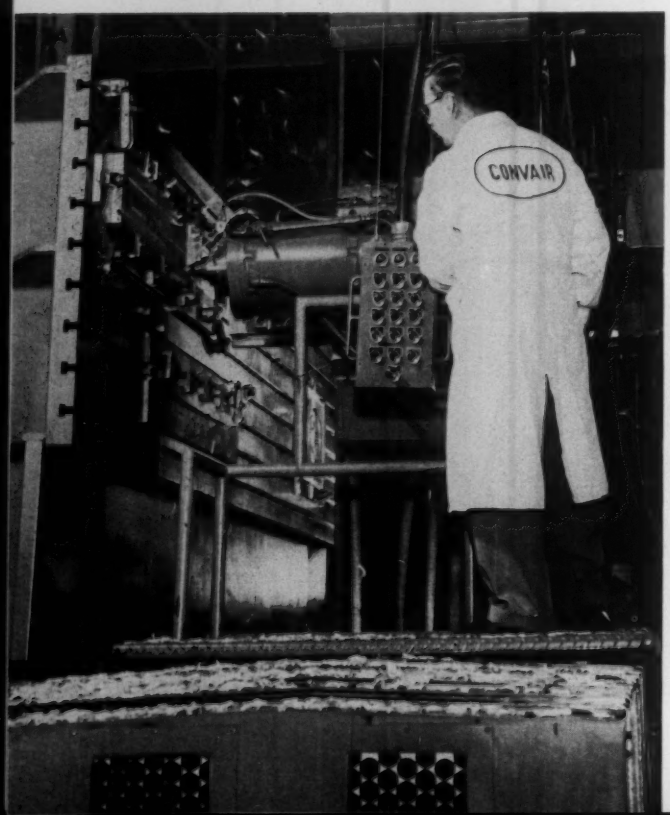


. . . as time goes by and personnel become better acquainted with the equipment, maintenance takes on a less serious aspect and becomes a more routine problem . . .

In general, most companies follow the same preventive maintenance procedures on the machine tools as on the tape handling equipment. Almost without exception, they follow the practice of turning the machines over to the maintenance department for cyclic checks at regular intervals.

Scheduling Maintenance

The maintenance department must schedule its operations so that personnel are available whenever equipment breaks down. The loss of a machine producing at ten times the rate of conventional equipment can have a serious effect on shop output



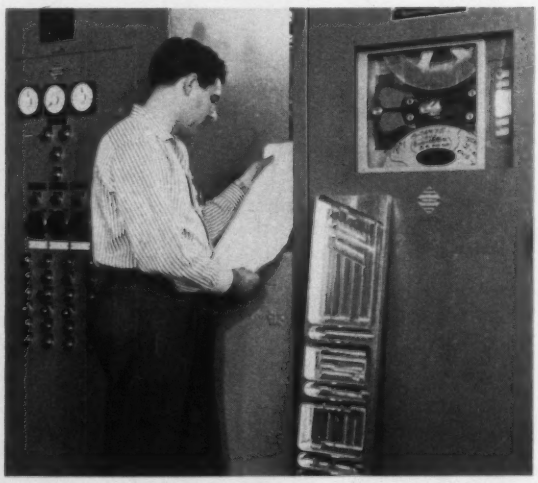


Fig. 2—Many types of numerically controlled machine tools are being used by the aircraft industry. This profile mill, built by Giddings & Lewis Machine Tool Co., is in operation at Convair—San Diego on a 2-shift, 6-day basis and is shut down once a week for cyclic checks and preventive maintenance. Mill is controlled by a Numericord unit through a General Electric Co. tape transport unit shown above. Inspector checks the machine program against an actual part.

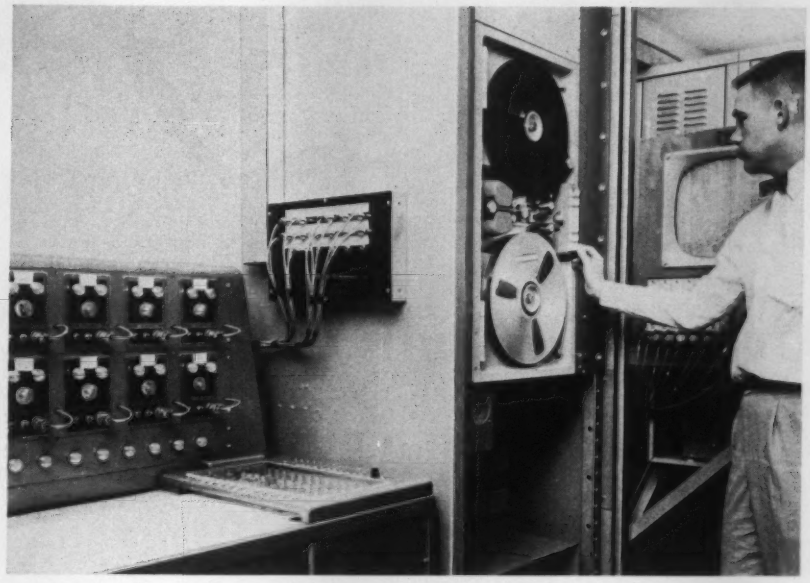


Fig. 3 — Special checking equipment can be a big help in maintaining numerically controlled machine tools. This tape checking unit, developed by Boeing Airplane engineers, is used to check out all axes of motion and intermittent functions on a magnetic tape before the tape is placed on a production machine tool.

if it remains inoperative for long periods of time. Thus, there can be no thought of allowing the maintenance department to schedule repairs at its convenience. When a repair is required, it must be made immediately.

Conversely, because faults may be difficult to locate, the time period that is required to make a repair is longer than on conventional equipment. Production departments are learning that they cannot expect equipment to be back on the line immediately after maintenance personnel go to work. In some cases, the repair has required a day or longer. However, this time lag is constantly being reduced as the experience factor on the equipment improves. All users have found that, as time goes by and personnel become better acquainted with the equipment, maintenance takes on a less serious aspect and becomes a more routine problem.

Such things as a spare parts kit list and a simplified maintenance manual are being maintained by most air frame producers. In general, the industry is maintaining a larger inventory of spare parts than originally anticipated. Mainly, this has resulted from heavy loading on equipment—many tools are on a 2-shift, 6-day basis, and some have been operated around-the-clock on a weekly schedule. In addition, no manufacturer wants to wait for spare parts to be shipped from the factory while a machine is down. An outage of several days can be responsible for a sizable loss in production on equipment of this type, and so the "better safe than sorry" attitude prevails.

So far as simplified maintenance manuals are concerned, the users are in general agreement that the equipment manufacturers have done an excellent job, through schools and written instructions, in detailing the procedures for locating and correcting the causes of equipment outage. Now, it is felt, somewhat abbreviated instructions are in order. When these are prepared—some users are doing this on their own—visual aids are being incorporated whenever possible. Such aids can be particularly useful in acquainting additional personnel with the intricacies of the equipment.

▶ Maintenance Pays Off

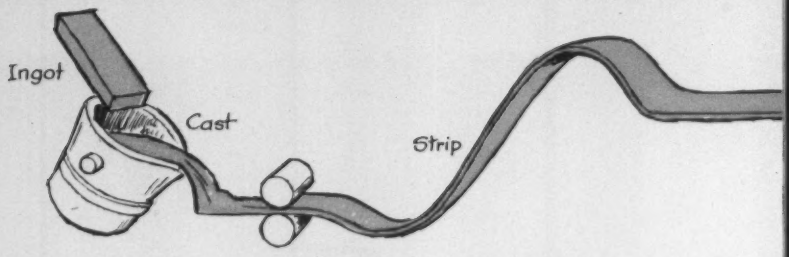
No matter how you look at it, maintenance has a negative connotation. It isn't the fact that maintenance is required (just as on any equipment), or the amount (which has been nominal considering the newness of the concept and the designs), but rather the complexity of the machines that has raised some doubts in the minds of potential users.

There is no question that numerically controlled machine tools and related equipment represent a new type of maintenance problem—substantially different than that occurring on conventional equipment with which the shop became well acquainted heretofore. However, it has now been proved that, through proper training and exposure, the aircraft industry has been able to keep its equipment in scheduled operation. Obviously, the seriousness of the maintenance problem is far less than many users have been led to believe.

On the other hand, the results that have been achieved are better than most of the ardent enthusiasts anticipated. In some cases, production rates on numerically controlled profilers and skin mills are up 5 to 10 times over conventional equipment. Both tooling costs and manufacturing costs have been greatly reduced, and most important of all, lead times have been cut to a minimum.

Numerically controlled machine tools have been moved from the curiosity to the production stage faster than anyone anticipated. Their use on an increasing scale for work in other industries need not be hindered by misapprehensions concerning the severity of the maintenance problem.

AUTOMATION TODAY



CAN-MAKING INTEGRATED

FROM INGOT TO FILLING

INTEGRATION of operations into a single continuous processing arrangement has now been applied to the making of aluminum cans for beer. At the Golden, Colo., plant of Adolph Coors Co. 50-pound aluminum ingots are put into one end of a line of equipment, and impact-extruded cans, decorated and lined, ready for filling, are discharged from the other end. Filling and closing of the cans and packaging in 8-can packs is presently performed in another plant, but plans have been developed to combine these operations with the can-making process. A single line will then include the operations from ingot to 8-pack ready for delivery.

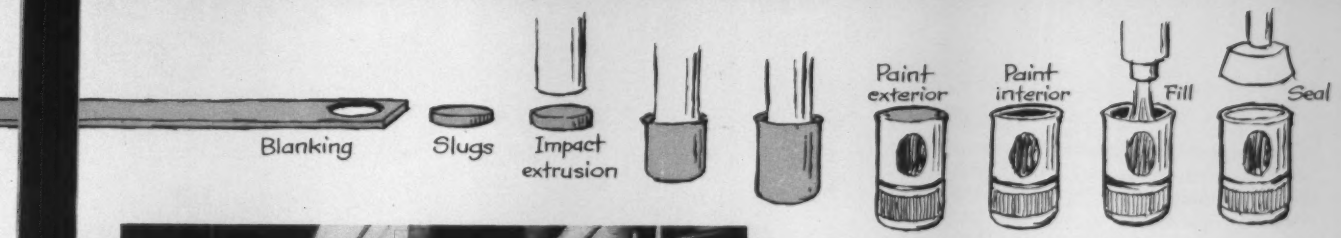
The continuous can-making line is the result of development work undertaken for Aluminum International Inc. This corporation was formed about four years ago by Beatrice Foods Co. of Honolulu and by Coors to develop an economic process for manufacturing aluminum cans for food and other industries. Both companies were interested in possibilities of aluminum beer cans for their brewing operations. For Beatrice, conventional can sources were not available, and an aluminum can to be manufactured at the brewery itself seemed the answer. Adolph Coors Co. was designated the research and development arm of the project. Now, after identifying and surmounting many problems, they have an operating facility in production on aluminum cans.

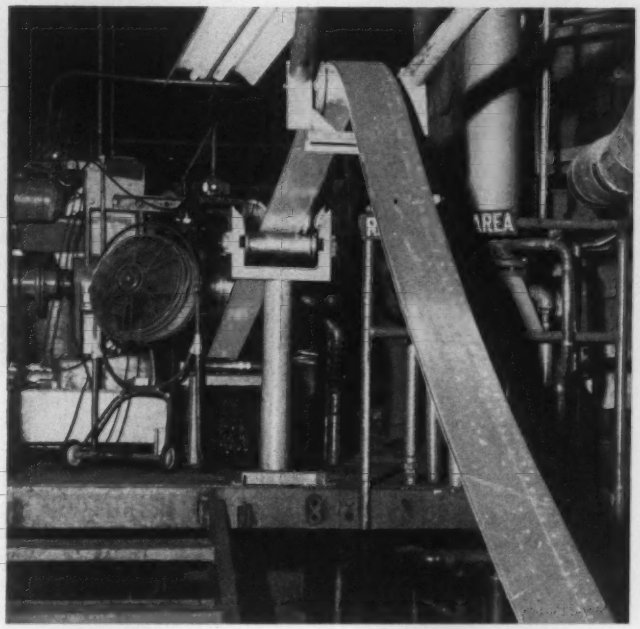
1

Continuous process for making aluminum cans begins with melting of 50-pound aluminum ingots in electric induction furnace. Unit has two compartments, one for melting, second for holding the molten aluminum at casting temperatures. Metal is poured from the furnace into a rotary casting wheel. Normal capacity of furnace is 2000 pounds per hour but this has been increased to 3000 pounds by preheating billets.

Making Extrusion Slugs

Key phase of the can-making process is the production of slugs to be used in the impact extrusion presses. The slug for each can is 2 3/32 inches in diameter and about 1/8 inch thick. Raw material





2

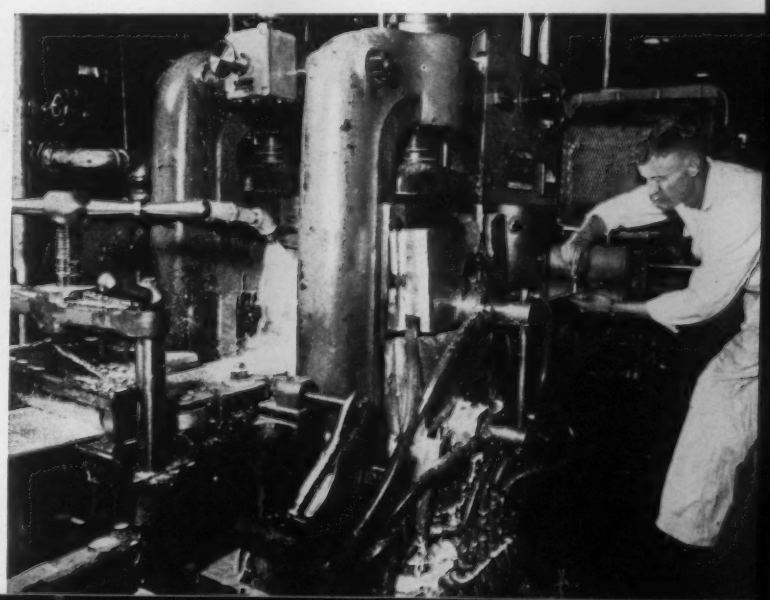
Thin continuous strip of cast aluminum is obtained from the special casting process. Strip is ½ inch thick and 4 to 8 inches wide. In this installation it is cast at a rate of 10 to 15 linear feet per minute and passes directly into a hot rolling operation.

for the slugs is 99.5 to 99.7 per cent pure aluminum purchased as ingots from prime aluminum suppliers. The ingots are melted in a 450-kilowatt electric induction furnace which operates at about 1300 F and has a capacity of about 3,000 pounds per hour if the ingots are preheated.

From the furnace the molten aluminum flows into a continuous casting operation perfected by Coors engineers to cast thin, wide sections of aluminum strip. Factors involved in continuous casting were studied for well over two years. Then Coors engineers designed a casting wheel on which variables could be controlled, and successfully began to cast continuous aluminum strip more than a year ago. Strip for cans is cast ½-inch thick by 4 to 8 inches wide. It is possible in their equipment to cast strips 1-inch or more thick with related widths. The ½-inch material is being cast at a rate of 10 to 15 linear feet per minute. Speeds from 30 to 45 linear feet per minute are said to be possible with the proper furnace capacity.

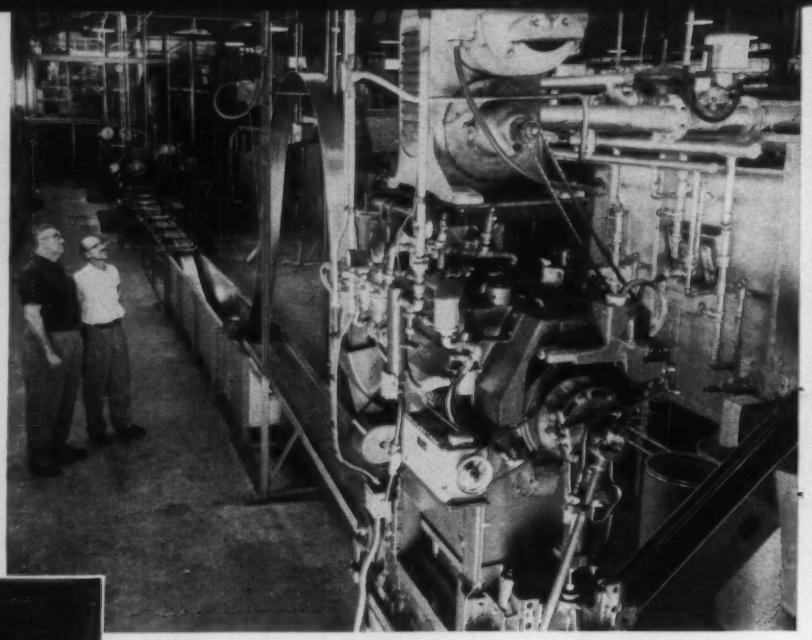
The cast strip is reduced in thickness in a hot rolling operation, cooled, and then cold-rolled to final thickness for extrusion slugs. When stock is being prepared for can lids, it is coiled after rolling, annealed, and re-rolled on another mill. Stock for lids is rolled to thicknesses of 0.015 to 0.020 inch ±0.0005 inch.

Strip stock rolled for extrusion slugs is fed directly into a blanking press which blanks out the slugs. The slugs are annealed after blanking and then washed, deburred, and lubricated. Scrap from



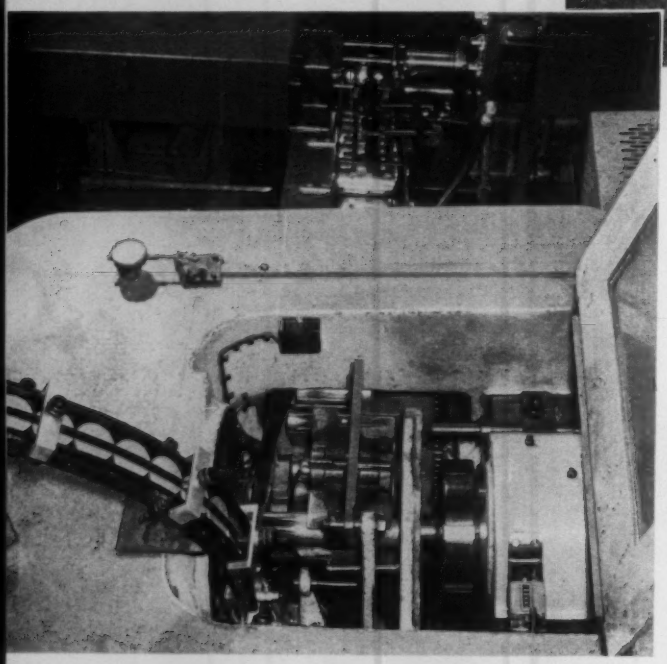
3

After hot rolling, the strip is cooled and then cold rolled to about ⅛-inch thickness. Strip, for slugs to be extruded into can bodies, moves continually into a blanking press that punches out the slugs. When stock is being cast for can lids, it is rolled, coiled, annealed, and then re-rolled to final thickness of 0.015 to 0.020 inch depending on the lid design.



4

General view of section of the line shows casting area in upper left. Continuous aluminum strip passes through rolling and cooling operations to looping pit and blanking press in foreground. Slugs are blanked out and carried up elevator at right to pass through annealing furnace. Scrap from the blanking operation is returned to the melting furnace so that there is no waste in slug production. After slugs are annealed to a "dead soft" condition in a 1½-hour passage through the annealing furnace, they are washed, deburred, and lubricated.



5

Actual impact extrusion of the slug into a flat-bottomed seamless can is performed by one or the other of two presses such as shown here. Each press extrudes 3600 cans per hour. Slugs are fed in from the left, and the extruded cans are rolled out of the press to the trimming machine in the background.

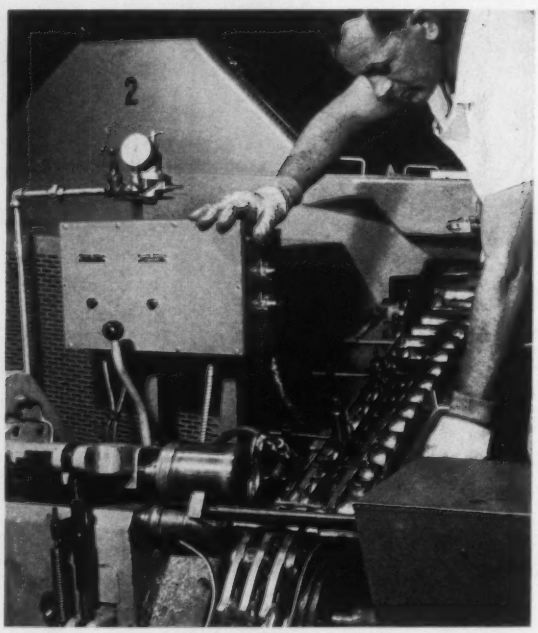
the blanking press is returned to the melting furnace, and there is no waste in slug production.

This process for converting aluminum ingots into extrusion slugs at low cost is said to be the essential key to the economic manufacture of aluminum cans.

▶ Can-Making

Cans actually take shape in two German-made impact extrusion presses. Each of these 400-ton machines can extrude 3,600 flat-bottomed seamless cans per hour from the prepared slugs. These presses were reworked by the Coors people to adapt them to this aluminum can process.

After can bodies are formed by impact extrusion,



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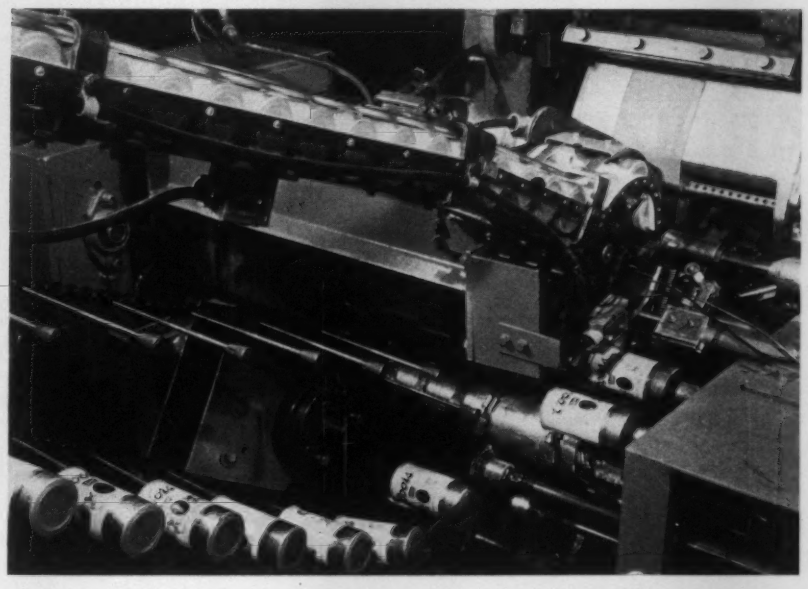
Immediately following the extrusion operation, the cans are trimmed to length and flanged. These operations are followed by degreasing, mild etching, and rinsing. The cans are then ready for decorative painting on their outer surfaces.



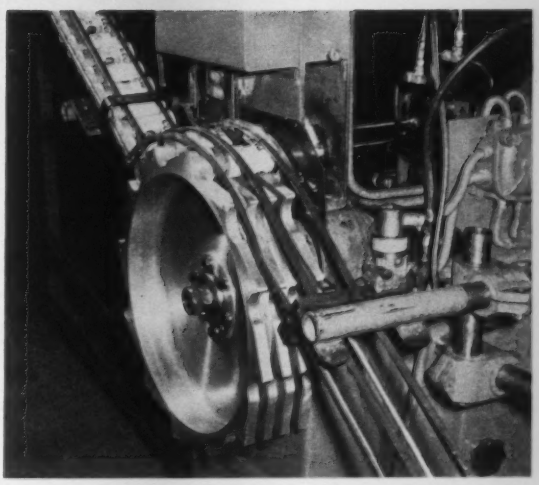
7

Cans are decorated in this 4-color cylindrical offset lithography press. It prints four colors on each of four cans for each revolution of its drum. Decoration of 6000 to 7000 cans per hour conforms to over-all output of the can-making line. An overcoat of varnish is also applied. The freshly decorated cans are automatically loaded on pins for a zig-zag trip through a drying oven 20 feet long.

they are trimmed to length and flanged, degreased and mildly etched, and rinsed. Then the cans are decorated in a 4-color cylindrical offset lithography press made by Alfons Mall Co. of Germany. As originally installed at the Coors plant, the press printed only one can with each revolution of the drum. It was reworked so that now four cans are printed on each revolution, and it can be operated at a below-capacity speed of 6,000 to 7,000 cans per hour which will handle the production of the can-making line. Besides applying four colors, this machine also puts an overcoat of varnish on the cans.

Painted decorations are thoroughly dried by baking in an oven; a protective internal coating of "beer vinyl" is automatically applied; and the cans are again baked. The cans are then ready for filling and closing.

The accompanying photographs show some of the steps in this production sequence.



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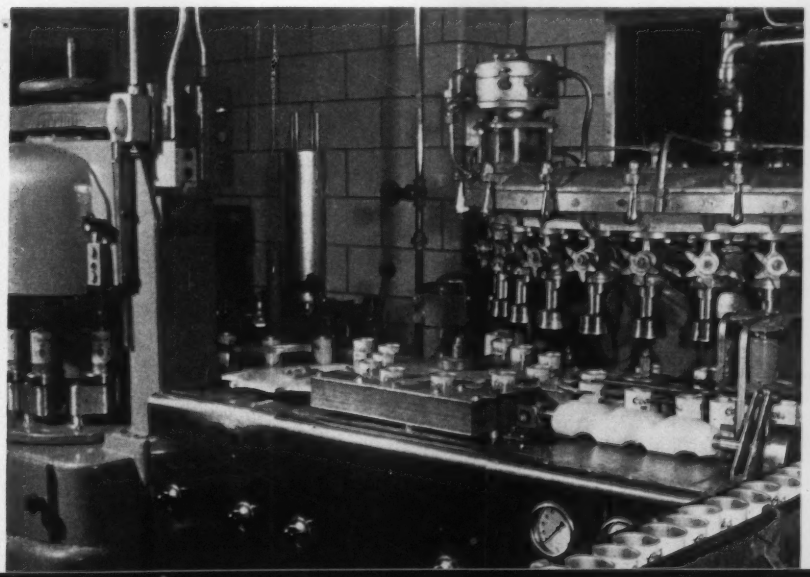
After the exterior decoration is dried, this station in the line applies a protective internal coating of "beer vinyl." The cans are then baked once more, this time riding through an oven on a flat wire conveyor.



9

Final operations for the aluminum beer cans are being performed in a nearby brewing plant. The aluminum cans are filled with draught beer which has not been subjected to heat. This is pointed out as a first by Adolph Coors Co. to accompany their achievement of being the first U. S. brewery to solve the problems for economic manufacture of aluminum cans. An important factor in the economic consideration is that the cans will be returnable at one cent each. Coors also hopes this salvage feature will reduce litter.

STANDARDIZING ASSEMBLY MACHINES

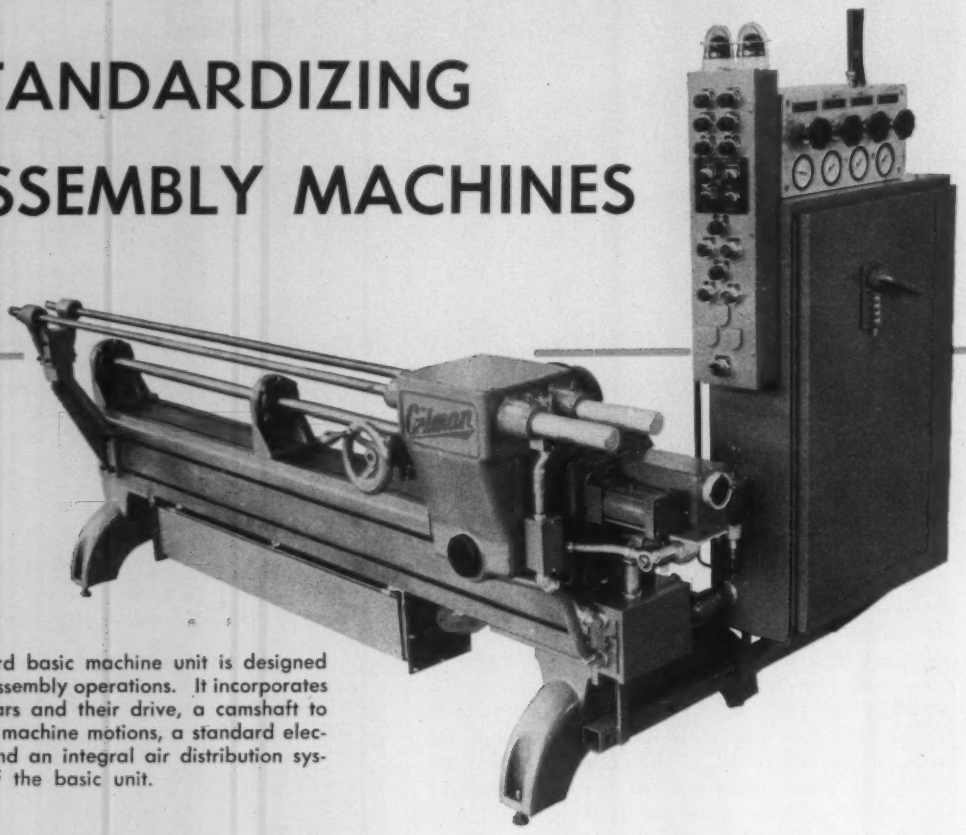


Fig. 1—Standard basic machine unit is designed for automatic assembly operations. It incorporates two transfer bars and their drive, a camshaft to co-ordinate all machine motions, a standard electrical circuit, and an integral air distribution system as part of the basic unit.

By **WILLIAM C. CUMMINGS**, President, Gilman Engineering & Mfg. Co., Janesville, Wis.

TREMENDOUS NEEDS for automatic assembly equipment are bound to be met. The rising cost of labor has forced the issue. Efficient equipment for assembly can show greater labor savings than any other single type of industrial equipment. Yet the cost of efficient equipment is very high due to the special nature of each machine.

The answer to this demand by industry is an assembly machine which will incorporate basic principles required for successful operation, and one which can still be produced at a reasonable figure. Standardization is the only solution. Of course, no one can put a machine on the market that will automatically assemble just anything that comes along. But there can be standardization to a point where most of the basic requirements can be met by supplying, off the shelf, a standard basic transfer unit and standard station movement mechanisms which incorporate the principles necessary for successful operation.

Assembly Machine Principles

In the next 10 years, tremendous strides will have been made in automating assembly operations. New principles will have been evolved. But by far the greatest majority of successful installations will have applied the following basic principles:

Provide Rugged Stability. There is always a question as to the proper balance between strength and stability of a moving body and the resultant increased inertia and momentum of the body. It must be remembered that once a machine is built, it will not be operated by engineers and designers but by production people who expect it to do that for which it was designed, and who will swear at it, hit it, and otherwise molest it when it doesn't perform. The first reaction of 99 per cent of the populace to a coin-operated telephone or vending machine, when their coin is lost, is to hit—and hit hard. An automated assembly machine must be built on the rugged side to withstand similar action by the ordinary production worker. In providing a more rugged design, the heavier elements must have controlled motion to offset their greater weight.

Incorporate Safe Transfer. The transfer movement can be obtained from any of a variety of dial, or inline mechanisms. However it is obtained, it should have the following characteristics: 1. Controlled movement. A cam actuated transfer will give a control of the acceleration and deceleration of

Automatic performance of assembly operations is one of the production techniques offering greatest potential savings today. Standardization of equipment to perform these operations is important to overcome the economic disadvantages inherent in building a completely custom machine for each application. The author outlines basic principles for successful assembly machines and describes a line of equipment developed to meet the need for standard units embodying these principles.

transfer. 2. A positive slip clutch or 100 per cent overtravel feature to prevent breakage. 3. Complete checking of the movement in the operational circuit to make certain that the movement has completed itself and returned to start.

Loading Movements Must Be Positive. It is so simple to obtain a loading motion by hooking up an air cylinder that it seems most foolish to do anything else. But, the loading movements are the arteries of the machine. They should be cam controlled to obtain maximum efficiency and a minimum of malfunctions. Furthermore, they should, when possible, be moved away from the work by cam rise, and moved toward the work against cam fall, by means of weight, spring, or air actuation. In such a design, the camshaft can continue to rotate but the movement can be locked out automatically as desired when a faulty assembly comes through.

Secondly, the loading movement should have a slip clutch, detent, or other allowance for 100 per cent overtravel in both directions to eliminate breakage. Thirdly, there should be a completion-of-movement check in the operational circuit which will stop the machine if the loading movement fails to complete either its forward or its return stroke.

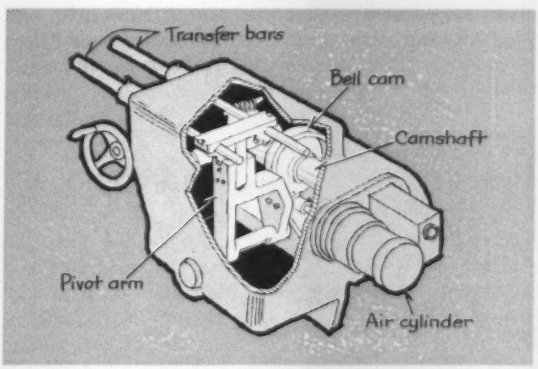


Fig. 2—Drive shown reciprocates the transfer bars of standard machine under control of bell cam on the central camshaft running the length of the machine. Design of unit allows the camshaft to continue rotating without damage even though the transfer bars may be blocked from moving in either direction. Protection in forward travel is provided by using air cylinder to urge follower against cam. Detent in yoke arrangement gives protection on return travel.

The loading movement can be a shuttle, a ram, a plunger, or a combination of these, but whatever it is, the part to be loaded should be controlled its entire distance of travel until it is properly seated, screwed, or pressed into the assembly. Gravity drops from simple escapements sometimes work, but controlled fingers that place a part properly are certainly more positive. Remember that the loading movement will be repeating itself from 5000 to 30,000 times per day and a very high percentage of failure can't be tolerated.

Synchronize Transfer and Loading Movements. For smooth operation and to prevent breakage, there should be complete synchronization between the transfer mechanism and each loading movement. If all movements are actuated by the same camshaft, or angle extension of that camshaft, the chance of misfiring is greatly diminished. An independent loading movement which is actuated by the assembly itself coming into position is usually successful, but unless the transfer mechanism is based on a travel-and-free principle, it is not as safe as complete synchronization from one camshaft.

Check Readiness of Part To Be Loaded. To continue to assemble partial assemblies on a machine is the same as running a screw machine with one of the tools broken off. It is therefore sensible to make a simple supply check of each part as it becomes ready for loading. This can nearly always be done by a pressure switch at the bottom of a stack of parts coming from the hopper. If there has been a jam in the hoppers, or if a faulty part will not pass down the track, it is senseless to cycle further until after correction has been made. Therefore, such supply checks should stop the machine for a predetermined time. If the part, given that extra time, becomes ready, the machine should continue automatically. If it does not, the machine should shut itself off so that corrective action can take place.

Check the Work That is Done. If a part is loaded incorrectly, does not seat itself properly, or is faulty

so that it cannot make a good assembly, the fault should be determined by a check, and the electrical system should prevent the loading of further parts on that assembly at succeeding stations. Such checks should not stop the machine under any circumstances, or the efficiency of the operation will drop to a point where a hand assembly operation will look like a bonanza.

Let's take the example of a machine that assembles seven components to produce 1000 assemblies per hour. If there should be a 1 per cent fault in loading of each part, that could mean 70 faulty assemblies per hour. If these assemblies were not checked, good parts would be wastefully loaded on bad assemblies and serious jams at subsequent loading stations could occur.

But, on the other hand, if checks are made that stop the machine for manual correction, jams will be prevented but efficiency of operation will suffer tremendously. It would mean stopping the machine between 34 and 41 times each hour for periods of 15 to 10 indexes at each stop. The number of indexes lost per stop would depend upon the efficiency of the operator in removing or correcting the faulty assembly and restarting the machine. With 15 to 10 indexes lost per stop, downtime per fault is multiplied 15 to 10 times, and operating efficiencies in the example given would drop to between 49 and 59 per cent. On the other hand, if the assembly is checked and found faulty, a simple memory system can lock out all succeeding stations that would have loaded parts on that faulty assembly. The faulty assembly can then be rejected at a reject station. In this way, if 1 per cent of each part is misloaded, or is faulty, only 68 indexes are lost out of the 1000 per hour capacity, the faulty parts are ejected without damage to parts or stations, and the machine will be operating at 93.2 per cent efficiency. This is merely an example to illustrate the point, but from our experience, we feel that the check, memory lockout, and rejection system are so important that we will not design or build a machine without this principle.

Pinpoint Stoppage Causes. Unless a means, such as a light panel, is provided to indicate which movement has failed to complete its proper travel, considerable time will be wasted during shutdowns. For example, the machine will stop due to a loading movement being blocked, but without a light panel, an operator can look for quite a while before finding the trouble.

So, an indicating light panel, that pinpoints all of the checks for which a machine will stop, is a necessary adjunct to the operational features built into the machine. The panel should pinpoint the following: 1. The complete transfer movement. 2. The forward travel of each loading movement. 3. The return travel of each loading movement. 4. The supply of each part which is ready to load. The checking, memory lockout, and rejection system need not be pinpointed on the panel. This is a separate system to weed out faulty assemblies. The stoppages which the panel pinpoints, on the other hand, are serious conditions that can damage the equipment.

The principles just listed for successful assembly machines are not just ideas put on paper—they are principles that have been learned through hard experience, through trial and error, through designing and building automatic assembly equipment.

To incorporate the above principles, automatic assembly machines become pretty expensive for the average potential user. Yet, to attempt to economize by eliminating any of the principles is like putting your money on double zero at a roulette table. We have seen cases where assembly machines have been ordered, designed, built, delivered, and paid for; and then other companies have been called

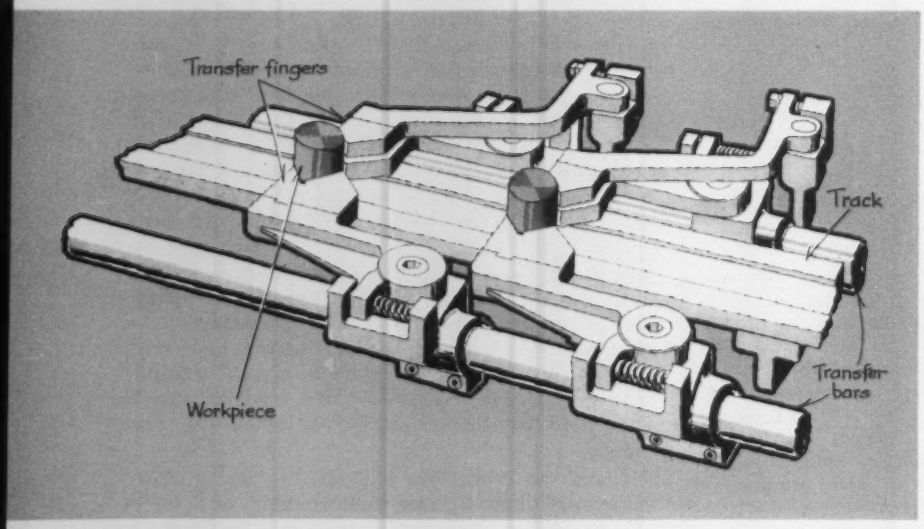


Fig. 3—Sketch illustrates use of transfer fingers mounted on transfer bars to advance workpieces along skid bar. Work is clamped in advanced position by station heads while transfer bars retract, strip fingers off the work, and engage fingers with succeeding parts.

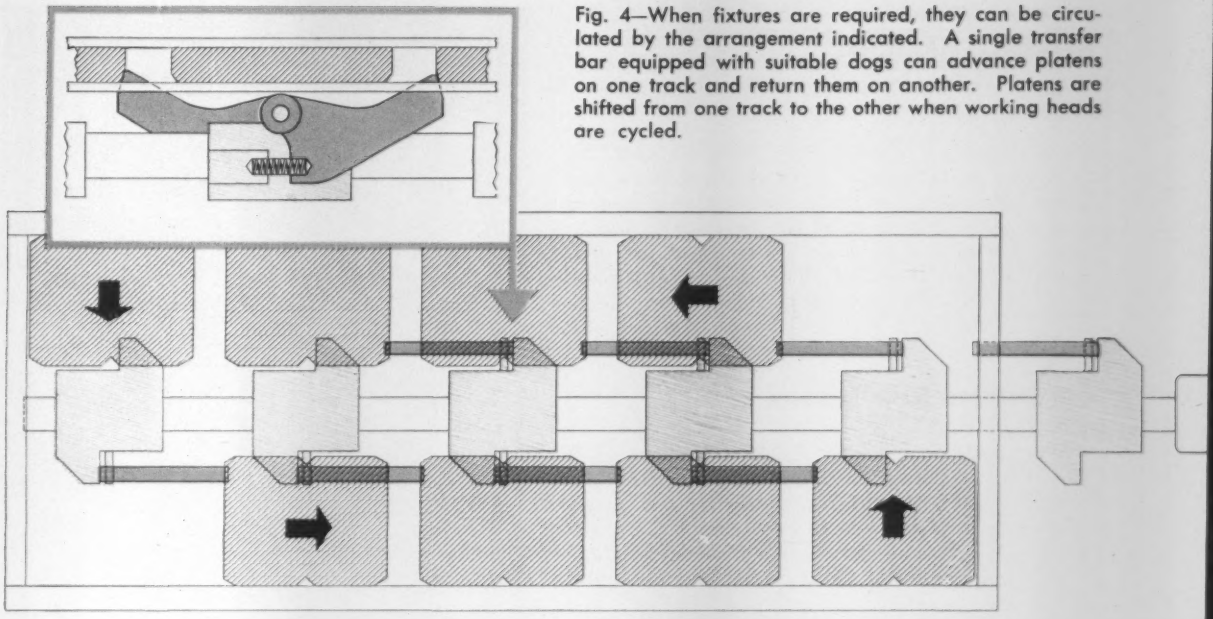


Fig. 4—When fixtures are required, they can be circulated by the arrangement indicated. A single transfer bar equipped with suitable dogs can advance platens on one track and return them on another. Platens are shifted from one track to the other when working heads are cycled.

in to try to make the equipment work. The inevitable answer is "salvage the hoppers, scrap the rest, and start again."

When a sizable investment has been put into the equipment and it still won't run, a small supplier may have to be bailed out to avoid bankruptcy. Others may fall back upon the *ifs*, get their money, and go their way. Many larger companies are certainly capable of building assembly machines—they have the engineering staffs to do the job—but since it is not their bread and butter, they have failed to build up staffs that specialize in the intricacies of the business. Each assembly has different problems. Until an engineering staff has been through a sufficient number of automation assembly projects to know the pitfalls, they must resort to the fit-and-try school—and that costs money.

▶ Studying the Need

Since the only basic answer to industry's need for assembly equipment is a standardized assembly machine, our engineering department was put to work to study such a machine. We felt that such a machine should incorporate all of the *musts* that are vitally important, exclude some of the more costly elements that are not absolutely necessary, and use components that could be produced economically with proper tooling. In addition, we felt that the machine had to be designed for complete maintenance accessibility.

Our study indicated that the standard assembly machine should be an inline machine rather than a dial. Although the indexing dial has many attributes, such as permanently located fixtures; its flexibility and accessibility for maintenance are limited. There are also certain elements of cost inherent in a dial machine which do not occur in an inline type machine. Cam-controlled operations on a dial require a three or four-sided camshaft using miter gears, and even then many linkages must be set at an angle to use the various stations available. The inline, on the other hand, can utilize a straight camshaft the length of the machine. The loading and placement mechanisms are completely accessible for adjustment and maintenance. The camshaft linkages on the opposite side are also completely accessible. The study further brought out that there must be access to the assembly from the bottom as well as the top and sides.

All types of transfer mechanisms were studied and considered, such as over-and-under indexing conveyors, returnable fixtures, oval conveyor tracks, and many others. One of the most successful types of transfer units ever devised is the simple transfer finger type used on presses. It has been used on eyelet equipment since the turn of the century. Although some assemblies require fixturing, the study indicated that many assemblies could be adapted for transfer finger movement, and this was decided upon as the standard. Where fixtures are required, a very simple free platen system can be readily adapted to this same reciprocating transfer movement.

The study brought out that a standard cam-controlled movement could be obtained that would accomplish nearly every loading movement that has been used in our assembly machine experience—an experience that covered the placement of hundreds of different parts. Such a standard movement could eliminate costly individual design and one-at-a-time building of each loading movement. This standard movement should have up to a 7-inch movement in

any direction. It should have complete checking built into the movement, to check the forward and return motions of the movement. It should have a slide or slide bars to guide the movement, and to which special tooling could be mounted for each individual part. It should allow 100 per cent overtravel in both the forward and the return directions, and finally, it should be economical to build.

Standard Basic Machine

As a result of this study, Gilman Engineering & Mfg. Co. developed the Transferline machine. It incorporates every principle which we had determined was a *must*. In addition, it meets the qualification of economy by means of standardization.

The basic machine, *Fig.* 1, consists of a base of any desired length with machined surfaces and T-slots for station mounting, a standard camshaft, and standard transfer bars located above and to the side of the main frame and free to ride back and forth through slide bearings. The reciprocating transfer bars will index the work from station to station either by means of transfer fingers clamped to the bars or by means of a rocking plate clamped to the transfer bar that indexes a set of free platens carrying such fixtures as may be required.

The basic machine also has a drive unit, consisting of a motor and a worm gear reduction unit, driving the camshaft which runs the length of the machine. On the end of the camshaft is a bell cam which actuates a simple lever to give the transfer bars a complete reciprocating motion on each 360-degree rotation of the cam.

The reciprocating motion of the transfer bars is controlled from the bell cam by its action on a pivot arm, *Fig.* 2. The fulcrum for this arm is at the bottom of the unit. A cam follower on the pivot arm is held against the bell cam by a constant pressure air cylinder.

The advance of the transfer bars is powered by the air cylinder. If the transfer bars meet an overload on the forward motion, the cam follower will not follow the cam. A cylinder was used here rather than a spring for the following reasons: 1. A cylinder gives constant pressure, whereas a spring would have to be too long to overcome the large variation in load caused by the spring scale. 2. If the forward travel is blocked and then the blockage is removed, a spring would be under load and cocked to slam the transfer bars to the end of travel. Using a cylinder, if the transfer bars do not arrive at the end of forward travel when they should, the air for the transfer is immediately exhausted. As soon as the blockage is removed and the transfer bars are pushed to the end of travel, the air pressure is automatically reapplied.

On the return stroke of the transfer bars, there is a direct linkage to the cam through a detent between the cross head connecting the two transfer bars and the pivot arm. To reset the detent after a blockage on the return stroke, the bars are easily pushed back into position without even opening the drive unit.

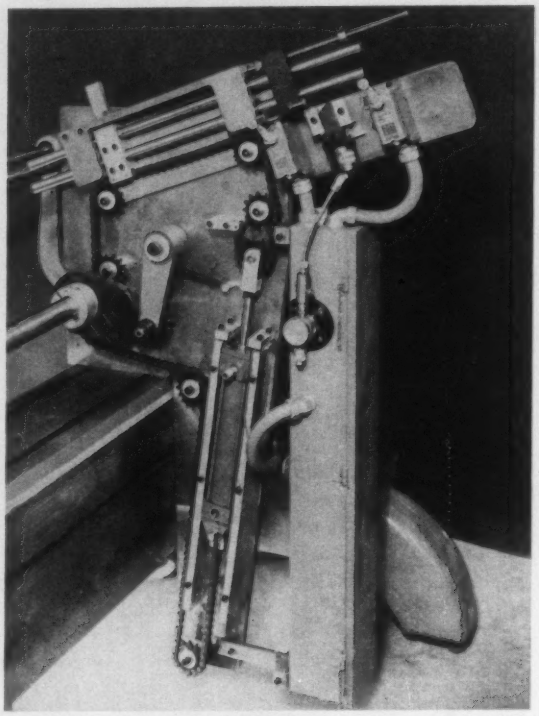


Fig. 5—Part positioning operations and platen shifting are performed by standard loading movements such as this. Motions of the slide are controlled by a cam on the central camshaft. Air cylinder and chain arrangement allows camshaft to rotate without damage to unit even when slide motion is blocked. Slide can also be selectively locked out when called for by preceding inspection check.

The clamping fingers on the bar are so designed that the cycle is as follows: 1. The forward transfer of the bar pushes the parts into the next position. 2. The working heads of each station descend and clamp the component parts in position as the inspection or assembly operation is performed. 3. After the parts are clamped, the spring-loaded fingers are stripped off the parts and returned, snapping over the succeeding parts. When the operations have been performed, the clamping or working heads release and the transfer fingers again advance the parts. One configuration of fingers to transfer short cylindrical elements is shown in *Fig.* 3. To tool the basic transfer machine for each assembly, it is necessary only to tool the individual sets of fingers which transfer the assembly from station to station, and to provide a proper dead plate or channel on which the assembly slides.

This system eliminates the cost of fixtures where a major component of an assembly can be shuttled

along as its own fixture. When it is required, the transfer mechanism can be built so that the transfer bars rotate to engage and disengage the fingers and the work.

There are many assemblies that require fixtures because they cannot be handled without them due to complexity of the assembly or due to delicate finishes. Circulating fixtures can be applied to the Transferline machine in the manner shown in *Fig.* 4. The fixtures are mounted on a group of loose platens. Only one transfer bar is used. The forward transfer of this bar pushes each fixture on the forward track ahead one station. These platens are held in position by shot pins. The return movement of the transfer bar then pulls the fixtures on the return track back one station. These fixtures on the return track are also shot pinned to hold them in position. When the working heads perform their operations, standard single movements at the first and last positions of the fixture system transfer platens between the forward and return tracks.

This system has the following advantages: 1. Since the fixtures are loose, they may be taken out for repair or replacement. Even if a fixture is taken out and not replaced, the machine can still be operated since the checking features will automatically lock out the affected loading stations as the empty space advances down the machine. 2. Side-by-side arrangement of the forward and return tracks permits a completely accessible return side for hand assembly, inspection, etc. An over-and-under conveyor, however, is usable only on the top side. 3. A system of loose platens permits accurate location of fixtures at each station since each platen is individually and independently shot pinned in its position. There is no buildup of tolerances and no shifting of positions due to chain wear as is possible on chain-type indexing conveyors.

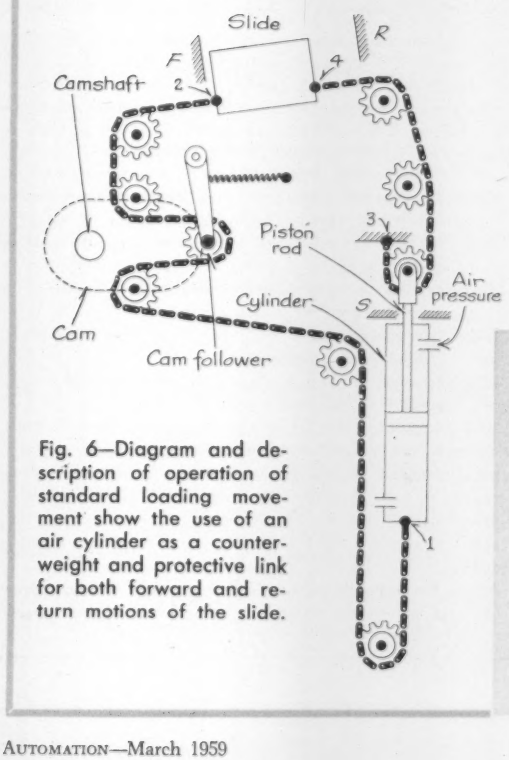


Fig. 6—Diagram and description of operation of standard loading movement show the use of an air cylinder as a counterweight and protective link for both forward and return motions of the slide.

When the air cylinder is not seated against stops, *S*, a given constant pressure in the air cylinder creates a force, *f*, on the piston rod and on chain *1-2* attached to the cylinder at *1*. Chain *1-2* pulls on slide with force, *f*, at point *2*, urging it toward forward stop, *F*. Piston rod pulling on chain *3-4* pulls on slide at point *4* with force, ½*f*. Slide is thus urged toward *F* by a force, ½*f*, plus any force due to weight of slide and tooling.

When the cam allows its follower to move to the left, air entering the cylinder causes the cylinder to move up against stop *S*. Further motion of the follower to the left reduces the pull of chain *1-2* on slide. Piston moves down in cylinder as pull of chain *3-4* urges slide toward return stop *R*, with force of ½*f*, less any force due to weight of slide and tooling.

▶ Standard Loading Movements

Individual stations are provided with standard loading movements, *Fig.* 5. These standard feed mechanisms are mounted along the bed of the basic machine by means of T-slots. The slide of each standard movement will provide up to 7 inches of travel controlled by a cam on the camshaft of the basic machine. The line of travel can be set anywhere from horizontal to vertical.

The slide assembly on each loading mechanism carries a block on which appropriate tooling can be mounted. The slide is moved toward the transfer rails when the cam displaces its follower, and the slide moves away from the transfer rails when the cam drops away from its follower, *Fig.* 6. The constant pressure air cylinder serves as a counterweight for the slide and tooling. The cylinder also provides 100 per cent overtravel protection for both the forward and return motions of the slide. The camshaft can rotate without damage to the loading movement even though the slide may be blocked.

Limit switches actuated by the slide sense when the slide is in its extreme forward and return positions so that this information can be used for interlocking control of other machine actions. When preceding checking stations call for the loading movement to be locked out, a pneumatic cylinder extends a mechanical latch that holds the slide out even though the cam continues to rotate.

▶ Standard Control Circuits

Use of standard control circuits to simplify application has also been adopted. A standard wiring system and diagram was devised to incorporate all of the features and basic principles which Gilman

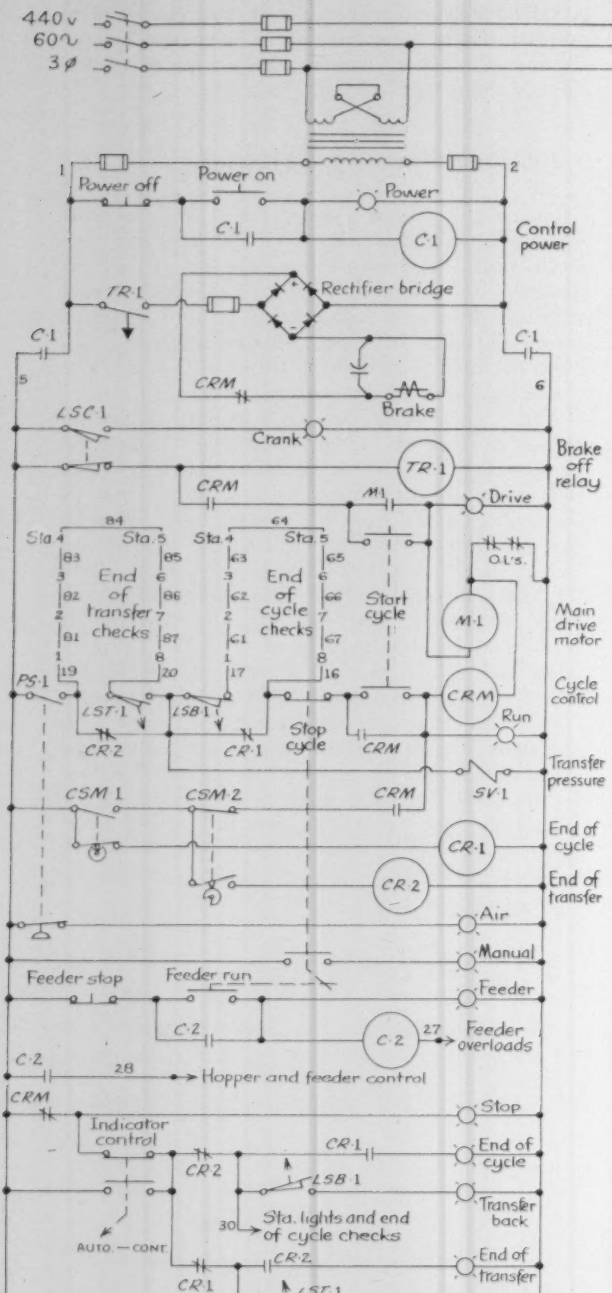
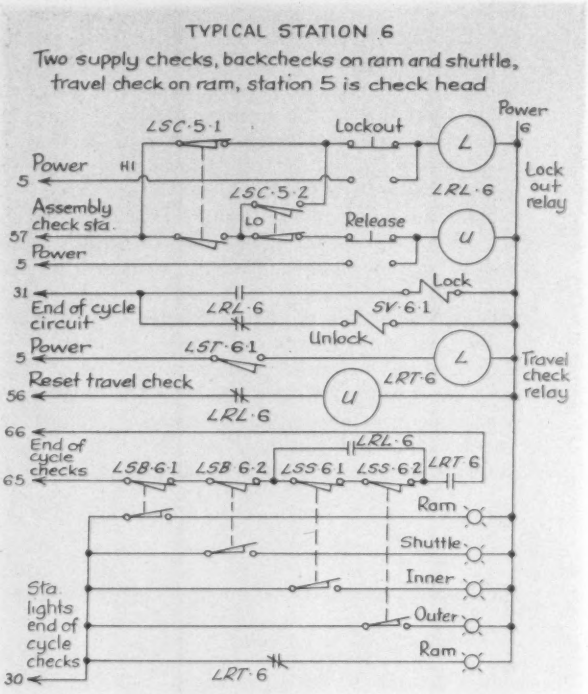


Fig. 7—Standard electrical control circuit for assembly machine base is shown by this elementary diagram. For a specific application, standard control circuits of loading movements, hoppers, and feeders are connected to the appropriate terminals of the basic machine circuit.



LSC1—Actuated when manual crank is engaged
LST1—Actuated when transfer bars are in fully forward position
LSB1—Actuated when transfer bars are in fully returned position
PS1—Actuated by supply of sufficient air pressure to transfer cylinder
CSM1—Released for end-of-cycle check when camshaft is at end-of-cycle position
CSM2—Released for end-of-transfer check when camshaft is at transfer completed position
CS1—Released for station full travel check when camshaft is just past end-of-transfer position
CS2—Released for part loading check when camshaft has just passed position for clamping of parts at check stations
LSC5-1—Actuated if part is too high at preceding check station
LSC5-2—Actuated if part is too low at preceding check station
LST6-1—Actuated by motions of mechanisms at the individual station
LSB6-1— "
LSB6-2— "
LSS6-1— "
LSS6-2— "
LSS A—Actuated when supply of parts from feeder A reaches preset level
LSS B—Actuated when supply of parts from feeder B reaches preset level

OPERATING SEQUENCE OF STANDARD CONTROL SYSTEM

Before the machine is started it should be mechanically "on zero," as indicated by the timing dials on the main camshaft or the cam switch unit on the end of that camshaft. The elementary electrical diagram is drawn for the zero, or end-of-cycle, position.

Main Power. When the main disconnect switch on the control panel is thrown to *On*, machine power lines receive 3-phase supply voltage and Lines 1 and 2 receive 110-volt control power.

Control Power. Pressing the *Power On* button energizes C1 and supplies control power to Lines 5 and 6 as indicated by the *Power* light. The large *Stop* light on top of the panel indicates that the machine is stopped and will not run until the *Start Cycle* button is pressed.

Feeders. Pressing the *Feeder Run* button energizes C2 and this energizes the various hopper and feeder control circuits. All supply mechanisms on the machine are thus controlled from one central point.

Indicating Lights. The indicating lights on the machine are interlock and fault check indicators. Normally, with the machine cycling and the *Indicator Control* switch on *Automatic*, the lights will be out except the *Run* lights. When the machine stops, specific indicating lights are energized to tell where (end-of-cycle or end-of-transfer) and why (manual, air failure, transfer checks, station interlocks, etc.) the machine stopped. However, with the *Indicator Control* switch on *Continuous*, the indicating circuits remain energized while the machine is running. This provides a convenient method of checking the circuits, timing, and interlocks.

Cycle Control. Machine cycle is controlled by *CRM* through a series of interlock and cam switches. An open interlock at either of the two check-stop points (end-of-cycle or end-of-transfer) will stop the machine. The fault must be corrected before the machine can be restarted by pressing the *Start Cycle* button.

With the machine at end-of-cycle, CSM1 is released, breaking the holding circuit to *CRM* and also energizing CR1. When CR1 is energized it opens the bypass circuit around the end-of-cycle checks, energizes the *End-of-Cycle* light, energizes the end-of-cycle circuits, and breaks the indicating circuit to the end-of-transfer checks. Before the machine can be started, sufficient air pressure to the transfer cylinder must be indicated by actuation of PS1, the transfer must be back to actuate LSB1, all other end-of-cycle station interlocks must be closed, and the *Stop Cycle* button must be reset. With these conditions satisfied, pressing the *Start Cycle* button energizes *CRM* to release the brake, energize the machine's large *Run* light on top of the panel, and energize M1 which starts the drive motor. Transfer motion and rotation of the camshaft will immediately begin. At about 3 degrees of camshaft rotation, CSM1 is again actuated to supply power to one holding contact of *CRM* and to de-energize CR1.

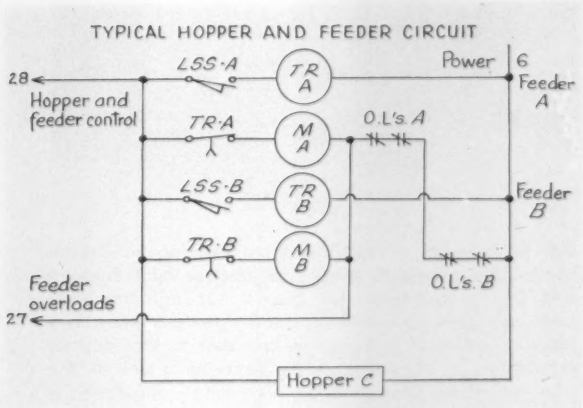
The machine continues to cycle, and CSM2 is released after the transfer is completed. Full advance of the transfer bars actuates LST1. Release of CSM2 opens one holding circuit to *CRM* and energizes CR2. Energizing CR2 opens the bypass around the end-of-transfer checks, closes the circuit to the *End-of-Transfer* light, energizes the end-of-transfer circuits, and opens the indicating circuit to the end-of-cycle checks. If all the end-of-transfer station interlock circuits are closed, and the transfer is forward to actuate LST1, *CRM* remains energized and the machine will continue to run. An open interlock will release *CRM*, de-energizing M1 and energizing the brake. The stoppage must then be corrected and the *Start Cycle* button pressed to restart the machine. With the machine running after the end-of-transfer check, CSM2 is again actuated, and *CRM* is held energized.

Immediately after transfer, checking heads come down against the work. These checking heads also serve as clamps to hold the work while the transfer bars return for the next cycle. About midway through this step CS2 is released momentarily, energizing one of the two coils of each station's lockout relay. If the part in the checking head is too high or too low, the lockout relay for the succeeding station is latched (LRL6 for example). If the parts are in proper position, the lockout relay is unlatched. Just after the end-of-transfer checks have been made, CS1 is released momentarily, energizing the circuit to the unlatch coil of each station's travel check relay (LRT6 for example). The travel check relay will be unlatched unless the station lockout relay is latched. After the travel check relay is unlatched it must be latched again by closing of the travel limit switch (LST6-1 in the example) or the machine will stop on the end-of-cycle check. At the end of the cycle, CSM1 is released and the end-of-cycle checks are made.

Although the *Stop Cycle* button is a maintained-contact type switch and may be depressed at any time in the machine cycle, the machine will be stopped by this button only at the end of the transfer or at the end of the cycle since the *Stop Cycle* switch is in series with the interlock circuit.

Emergency Stop. In the event of an emergency condition, the machine can be stopped at once by pressing the *Power Off* button. The drive motor will be de-energized and the brake energized to stop the machine. The brake will remain energized for a short period determined by the setting of TR1. After an emergency stop, the machine should be manually cranked ahead to the next normal stop position.

Manual Crank. A hand wheel unit incorporated in the transfer drive allows manual advance for use in setup, timing, and resetting after emergency stops. Limit switch LSC1 prevents the drive motor from being energized with the crank engaged. In addition, LSC1 breaks the circuit to TR1 when the crank is engaged, de-energizing the brake and allowing the machine to be manually cycled with control power on. LSC1 also energizes the *Crank* light to indicate that the crank is engaged.



Engineering felt were essential to a good assembly machine. The basic circuits in the standard electrical system for this machine are shown in *Fig.* 7. Steps in the operating sequence of this system are noted in the box accompanying the elementary diagram. A terminal junction box runs the length of the machine, and a unitized electrical box for each standard loading movement can be connected directly to this junction box without the necessity of going back into the main control panel.

A basic air system has also been included in the machine. It provides one air pressure for the transfer bar cam follower and three other pressures for various operations of the machine. A regulator unit as at upper right in *Fig.* 1 allows adjustment of these four pressures. Standard air lines run the length of the machine to make three air pressures available at any point. These air systems, as well as the standard electrical circuits, are included in the basic machine price.

Application Examples

One illustration of the application of standardized machine elements to an assembly operation is shown in *Fig.* 8. This unit places O-rings in bushings. The particular setup shown is tooled to provide two independent but identical series of operations arranged in tandem. In effect, it is thus two machines in one, both of which are performing the same operations. With the basic machine operating on a 2-second cycle and both sections functioning, the machine can produce 3600 assemblies per hour.

The basic machine is a 10-station unit. At Stations 1 and 7 bushings are loaded onto the transfer track (skid bar) from the elevating feeder. At Stations 2 and 8, check heads carrying switches come down to determine whether bushings are present and whether the proper end is up. If either of these checks is negative, the succeeding stations are locked out. Stations 3 and 9 each use two basic loading movements to take O-rings fed by vibratory hoppers and place them into grooves inside the bushings. Check heads at Stations 4 and 10 determine whether or not the O-rings are present and properly placed. Assemblies which fail these checks are rejected into a bin, those which pass are dropped onto a conveyor.

In this particular machine there is no rotation of the transfer bars. At most stations the loading movement clamps the part and overtravel of the loading movement performs the assembly or checking operation. At each of the stations loading the O-rings, two standard loading movements are used. One movement clamps the bushing while a second movement inserts the O-ring. While the bushing is clamped, the transfer bars are retracted, and the transfer fingers are stripped off the bushing. The transfer fingers then grip the succeeding bushing.

Elements for one station on another machine are indicated in *Fig.* 9. Two standard loading movements are used to screw a grease fitting into another part. The first movement shuttles a single fitting from a supply stack to a point above the assembly. The second movement carries a magnetic socket mounted on an air actuated torque wrench. The cam for the movement cycles the socket down to contact the fitting and up to lift it out of the nest on the first movement. The horizontal movement is retracted, the vertical movement descends, and the wrench screws the fitting into position before the vertical movement is retracted. Since both movements are operated from the central camshaft, they are synchronized with each other.

To provide this station, a hopper and track had to be engineered to bring fittings to a stacked position. The tooling on the horizontal movement had to be designed so that it would properly shove one fitting from the stack and hold the fitting until it was picked up by the magnetic socket. To complete the station, a simple pressure switch at the end of the stack of fittings can give part supply information to the control circuit, and forward and return switches on the loading movements have to be adjusted and wired into the control circuit.

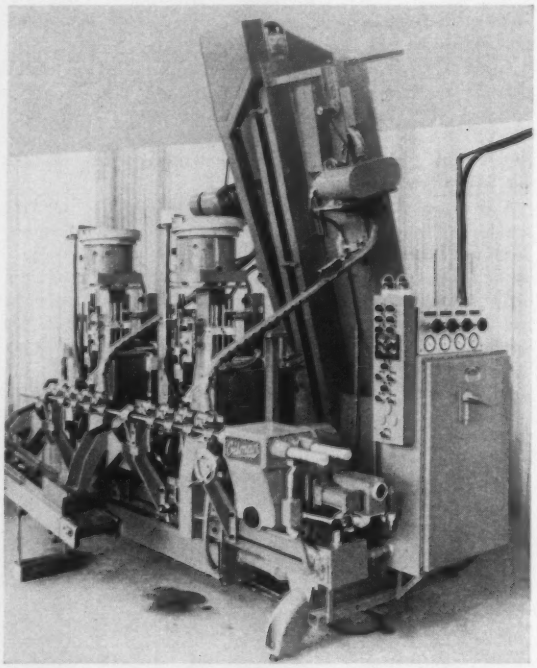


Fig. 8—Example of application of standarized assembly machine elements is used to produce 3600 bushing and O-ring assemblies per hour. Although the basic machine cycles at a rate of 1800 times per hour, two identical series of stations are provided so that desired production is obtained. Operation performed is the insertion of an O-ring inside a bushing. Inspection is an integral part of operation so that O-ring is not loaded unless bushing is properly placed, and faulty assemblies are rejected to a special container.

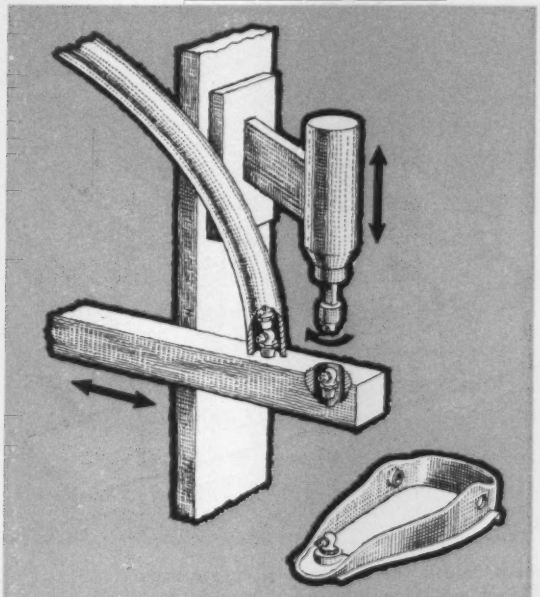


Fig. 9—Combination of two standard loading movements to assemble a grease fitting to another component is illustrated by this sketch. Advance and retraction of each slide is mechanically synchronized and controlled by cams mounted on the central camshaft on the machine base. Magnetic socket is used to hold fitting while the air wrench screws it into position.

Points to Consider

With the type of standardization discussed here, automatic assembly machines can be economically provided to a much wider segment of industry than has heretofore been possible. With the availability of such equipment off the shelf, any company can estimate the cost of an assembly machine with fair accuracy and can tool it themselves with a fair chance of success. Or it can be tooled by other firms who have had sufficient experience to eliminate a certain amount of fit-and-try costs.

It is possible for any company to estimate the cost of an assembly machine with reasonable accuracy because the base and drive carry a standard cost; each standard loading movement is quoted at a fixed price; and hoppers are quoted by many companies at fixed prices. It is then only necessary for the company engineering department to estimate the cost of engineering and building: 1. Transfer finger tooling. 2. Guide plate tooling. 3. Individual part tracks. 4. Tooling for each standard movement. 5. Movement cams. 6. Electrical wiring. 7. Electrical indicator panel. 8. Air lines and any supplementary cylinders required. 9. Hydraulic equipment desired at particular stations.

Companies that have done a good deal of work on automatic assembly have shown an intense interest in this standardization program. Many organizations have a high stake in this phase of the production picture and realize the tremendous benefits to be gained from standardization.

However, it is not the intention of this article to leave the impression that an assembly machine is nothing more than a snap of the fingers. It isn't as easy as some people would have you believe to build a workable assembly machine. Just because the technique of hoppering parts has improved tremendously over the past few years, it doesn't follow that you can simply hook up some hoppers to a table and come out smelling good. There has to be a good solid plan formulated that is feasible. The transfer of the assembly has to be studied to assure positive placement. The interim checking stations are tremendously important in the successful operation of the machine. Hoppers and tracks must be designed and built to assure an extremely high percentage of trouble-free deliveries, and the individual tooling of the loading movements must assure positive control at all times of the part to be loaded. Most important of all, each and every movement of the machine must be positively synchronized with every other movement. Rather than risk a costly learning period, a company that has had little experience in automatic assembly should certainly buy the tooling know-how that comes only from experience.

are you stuck?

In the past few years AUTOMATION has helped in the solution of hundreds of widely diversified practical problems in making operations more automatic. Regardless of the character of the operation or system being developed, somewhere in industry a similar problem has been solved and, very often, equipment is available or suitable techniques are known.

Development can be simplified, engineering costs reduced, and reliability guaranteed with tried and proved equipment and devices available today for achieving successful automation. Whether the problem is simple or complex, practical or technical, the Editors will be pleased to help find the right answer. The vast reservoir of industrial know-how is yours for the asking. Take advantage of this service. Write to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio.

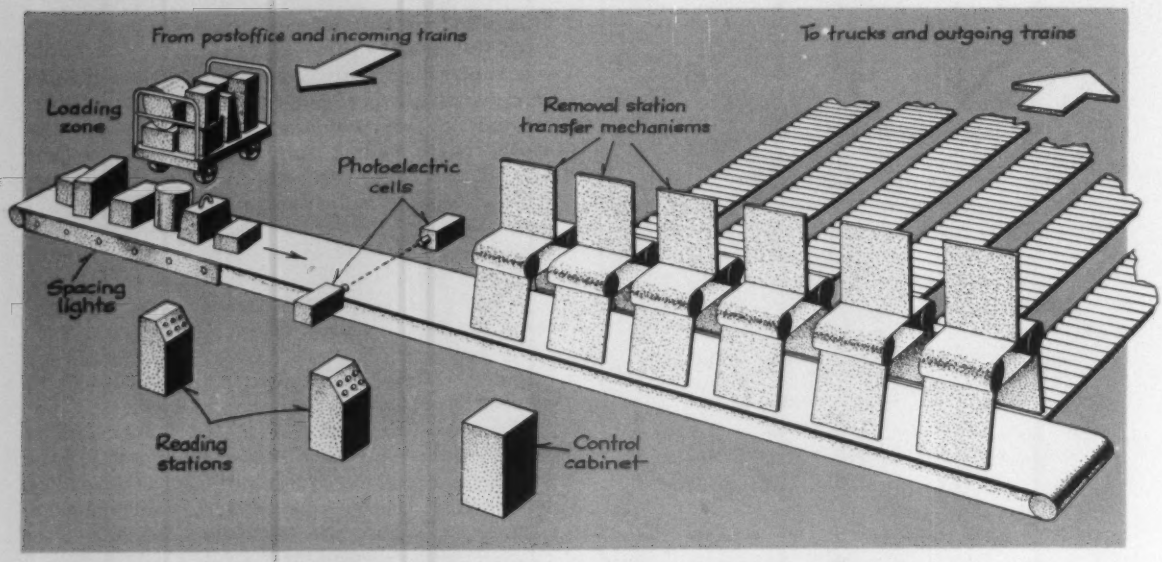


Fig. 1—Schematic illustrates the major components used in the electronic sorting system. Packages are manually loaded onto the 220-foot main conveyor which travels at a speed of 90 feet per minute. After reading operators enter pre-assigned code numbers for the package destination into a data input device, the information is converted into binary-coded data for use in a shift register. When the package reaches the proper spur conveyor, a transfer mechanism selectively sweeps the package off the main conveyor and onto the spur conveyor.

ELECTRONIC MEMORIES CONTROL

PACKAGE SORTING SYSTEM

By **ROGER W. BURTNESS,** Manager of Engineering & Research, Stewart-Warner Electronics, Div., Stewart-Warner Corp., Chicago, Ill.

INDUSTRIES whose primary function is the sorting and handling of materials are discovering that "the way we always have done it" is neither fast nor economical enough to cope with today's volume of flow and cost of handling. During the past decade the volume of materials handled has been increasing at a steady rate. At the same time, the cost of unskilled and semiskilled labor, commonly used in handling and sorting operations, has also been rising steadily. The combination of these factors has caused many industries to turn to automation as a means of handling large volumes at a reduced cost.

Evidence of the trend toward automation in the materials handling industries is the interest shown by the U. S. Post Office Dept.* The Office of Research and Engineering has been set up by this government agency to provide technical assistance in the application of modern engineering techniques to postal operations. With the co-operation of various manufacturers, this office is investigating the use of automatic letter reading and sorting machines; high speed culling, facing, and canceling machines; automatic sorting of parcels; and other equipment for handling mail speedily and safely.

Complementing the work being carried out by the U. S. Post Office Dept. are separate investigations by various railroads which also handle and sort large quantities of mail and parcel post. One of these railroads is the Pennsylvania Railroad which has recently installed an electronically-controlled mail handling system for unsacked parcel post packages in its Philadelphia terminal. In addition to saving money by reducing manual handling and

*"Mail Processing Advances With Automation," AUTOMATION, Vol. 5, No. 11, November 1958, pp 52-59.

Manual handling and sorting of packages is the costliest and most time-consuming phase of parcel post transportation. Automation for this problem is complicated by the large number of odd-shaped packages that must be handled and the numerous sorts required. A successful automatic sorting and handling system for parcel post that could be applied in other industries is discussed in this article.

visual sorting of "out-size" mail, the railroad is moving mail through the terminal 8 to 12 hours faster, is benefiting from more productive use of labor, and is experiencing better balanced, more economical loading of mail cars. Benefits also accrue to the addressee of the mail since packages are reaching destinations as much as a day earlier, due to faster handling and departure on earlier trains.

The Pennsylvania Railroad mail handling system was developed and installed by Stewart-Warner Electronics, Div., Stewart-Warner Corp., which has been working with railroads in the application of electronic methods to solve many railroad control problems. Material sorting resulted as a natural outgrowth of this program with the railroad industry. Previous work by Stewart-Warner in the digital computer field pointed up the advantage of producing a sorting system control which would use the same type of circuits, plugboard construction, and approach as had been used in the computer field. With this in mind, proved digital techniques were applied to the sorting problem.

System Operation

Mail handled in the Philadelphia terminal is received from the local postoffice or is unloaded from incoming trains. It consists of pieces too large to be handled in mail sacks and ranges in size from egg crates and film cans to hand luggage, trunks, crates, and cartons of all sizes. The mail must be sorted into various lots, depending upon the city of destination, and each lot must be transferred to the correct outgoing train. Prior to the installation of the electronically-controlled sortation system, fifteen men were required to load the incoming parcels onto a conveyor belt, mark them for subsequent removal onto roller conveyors, and to lift them off at the indicated removal points. Additional manual handling was required to further break down the lots at each removal point into different sorts by outgoing trains.

The new automatic sorting system, *Fig.* 1, accomplishes the same job efficiently and economically and requires only five men on the entire line. Randomly mixed pieces of mail are manually loaded onto a 220-foot powered conveyor at spaced intervals and in such a manner that the destination labels can be read quickly and easily, *Fig.* 2. To help space the parcels properly, a row of lights is mounted alongside the conveyor and is so controlled that bands of light appear to move at 3-foot intervals in synchronism with the conveyor speed.

There are 39 points in the system at which parcels can be transferred from the main conveyor belt to spur conveyors for the accumulation of mail destined for a particular city or outgoing train. Each transfer point is designated by a pre-assigned code number, such as 29 for Detroit. As the spaced parcels move along the conveyor, they are conveyed past two reading stations. Guided by a signal light

Fig. 2—Two loading operators space the incoming packages on the main conveyor at 3-foot intervals. Destination labels are oriented so that reading operators can read them quickly and easily. Two reading stations are used to handle the large volume of packages. Each operator reads every other parcel as it passes on the conveyor and enters a pre-assigned code number into a key punch. Coding plugs then convert the destination number into a 6-bit binary-coded number for use in the electronic shift register.

> ". . . because the electronic sortation system is instantly available at the flick of a switch, 24 hours a day, we are able to process even one truck load of mail as soon as it arrives. Previously, it was necessary to wait for an accumulation of unsorted parcels, perhaps 25 truck loads, before calling men from other essential jobs to man the sorting belt. Now, a maximum of five men can leave other work for a few minutes and handle all mail promptly. Mail 'makes' the first train out, after it arrives here . . ."—George C. Vaughan, regional manager, Pennsylvania Railroad, Philadelphia, Pa.

at each station which indicates parcels to be read at that station, an operator reads the destination of alternate parcels on the conveyor and enters the pre-assigned code number for the destination into the keyboard of a data input device. After the number has been recorded and checked, the operator depresses an *Entry* bar on the input device to enter the code number into the data handling system.

A block diagram of the data handling system is shown in *Fig.* 3. The input data, consisting of a decimal destination number, is directed to coding plugs which are used to convert the number into a 6-bit binary-coded number (29 would be 0 1 1 1 0 1) for use in the shift register of the package removal control unit. The use of coding plugs gives the system a high versatility of sorting and permits the reading operator to always use the same decimal number for a given destination. By switching the coding plugs as units, different spur conveyors can be used to accumulate parcels for a given destination, and changes in outgoing train makeup which occur from week to week can be readily accommodated. Each coding plug is set up to convert a decimal designation of the destination to a binary-coded number of one of the 39 spur conveyors.

After the destination of a passing package has been key-punched by a reading operator and converted into a 6-digit binary number by the coding plugs, the data enters a buffer storage unit. This unit consists of a number of neon indicators which are capable of igniting and passing current at approximately 75v and are extinguished at about 55v. If a bit in the binary digit is a 1, the respective neon indicator is ignited and passes current, and if the bit is a 0, the indicator remains extinguished and passes no current. The buffer storage unit temporarily holds the binary number in neon tube storage until the parcel on the conveyor passes a photoelectric cell, *Fig.* 4, which triggers the buffer storage unit and causes the transfer of stored data

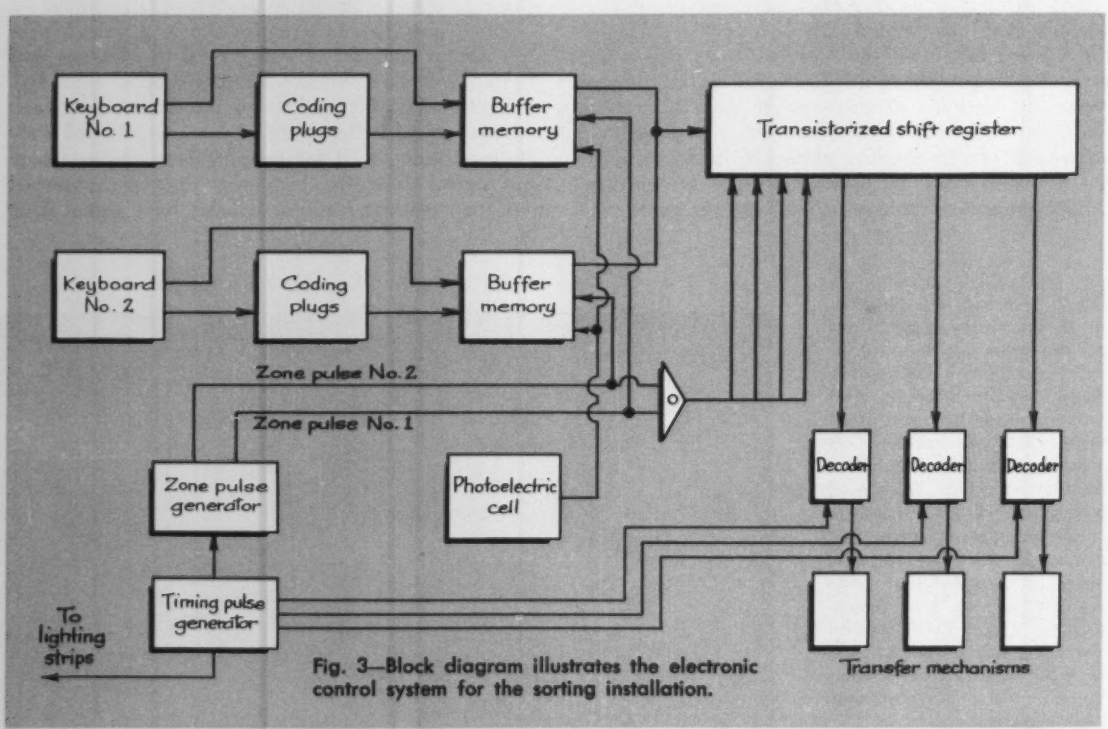


Fig. 3—Block diagram illustrates the electronic control system for the sorting installation.

to the transistorized shift register or main memory as a train of pulses.

The transistorized shift register is called a synchronous memory because the data or train of pulses move along in it in synchronism with the conveyor belt speed. The register consists of a series of transistorized flip-flop circuits which are triggered by a zone pulse generator giving one pulse for every 3 feet of belt travel. As the parcel is conveyed along the belt, the coded information designating the removal station is transferred from one set of flip-flop circuits to another. At each removal station, the position of the flip-flop circuits for that station is examined by a decoder consisting of a large *And* gate whose inputs are wired with the address of the station. Therefore, when the train of coded pulses reaches the correct set of flip-flop circuits, all outputs of the flip-flops in the circuit will create a high input to the *And* gate and make it capable of passing a pulse to a transistor amplifier used to operate a relay and start the package transfer mechanism.

Since the individual package transfer mechanisms are not located at direct multiples of zone length from the initial measuring point—the photoelectric cell—and are located at the most convenient spacing, a timing pulse is required to trigger the *And* gate of the decoder. This pulse is created by a timing generator which has a small wheel riding on the main conveyor belt and gives one timing pulse for every 3 inches of belt travel. Therefore, when the decoder *And* gate is ready to pass a pulse, the decoder awaits the proper timing pulse for the individual transfer mechanism. When this pulse arrives, the *And* gate operates the transistor relay which initiates a signal to start the transfer mechanism. This action causes an overhead paddle arrangement to sweep across the main belt, *Fig.* 5, and, firmly but gently, move the parcel from the main belt onto an inclined gravity conveyor set at

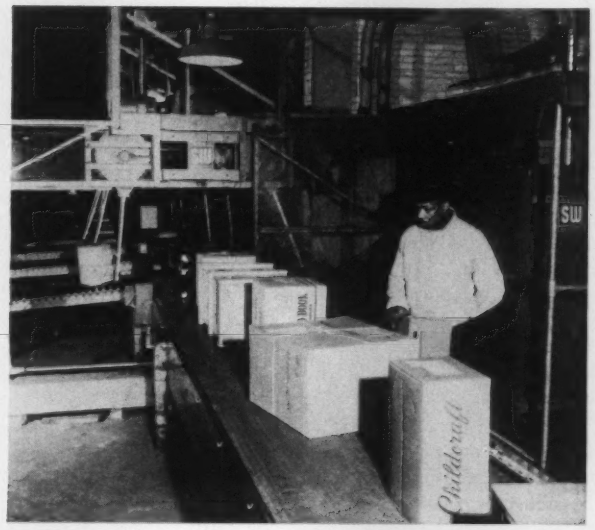


Fig. 4—After passing the reading stations, the parcels are conveyed past a photoelectric cell which shifts the binary coded destination data from a buffer storage unit to an electronic shift register. As the parcel advances on the belt past the removal stations, the coded information is transferred through sets of flip-flop circuits in the shift register. As the package passes each removal station, the data in the shift register are examined by a decoder to determine if the proper station has been reached. The control cabinet holding all electronic components of the system is at the extreme right of the picture.

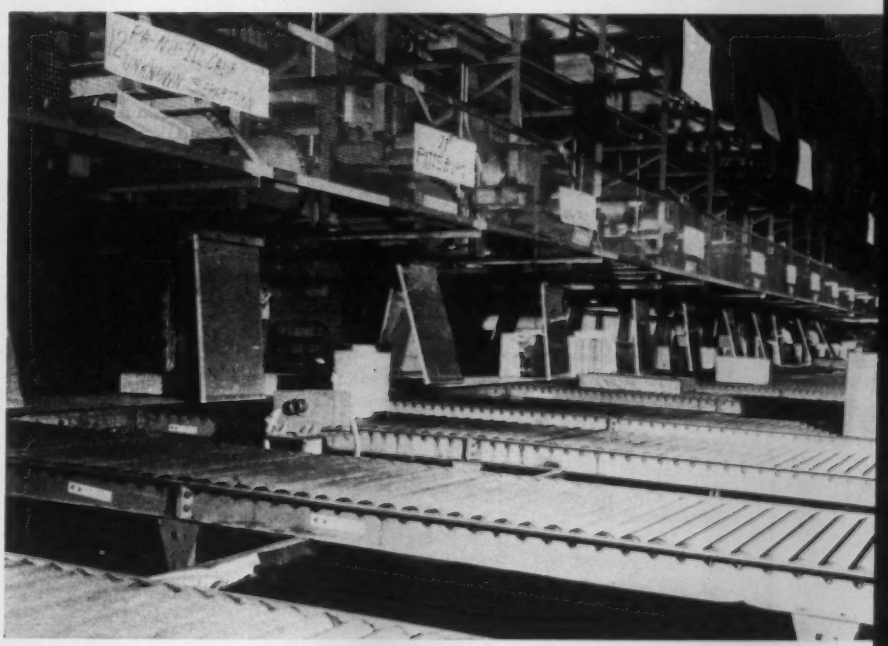


Fig. 5—When the package reaches the proper package transfer station, the decoder causes an overhead paddle-type transfer unit to sweep the parcel from the main conveyor. Packages accumulate on the spur conveyor until they are loaded onto trucks for transfer to outgoing trains.

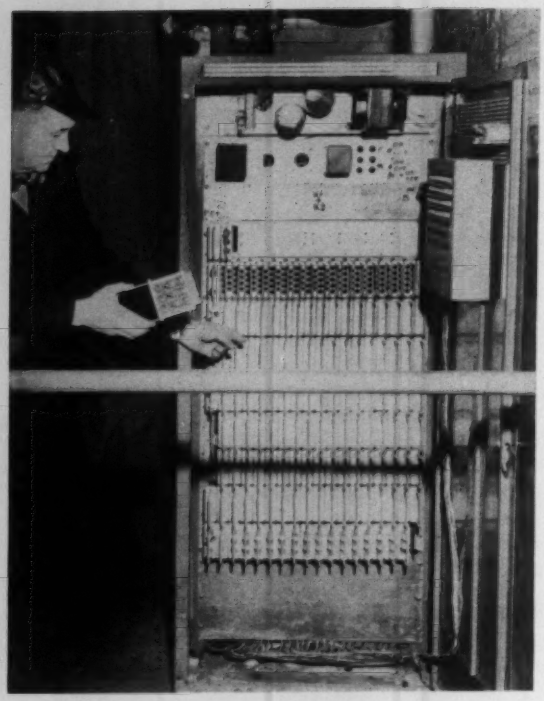


Fig. 6—Compact control cabinet holds all the electronic components used in the system. Most component circuits are mounted on convenient modular plugboards for ease of maintenance. All vacuum tubes, with the exception of a few in the power section of the system, have been eliminated from the system. A test board, enabling quick and easy checking of the system from one location, is also an integral part of the control cabinet.

right angles to the main line. The parcel then moves by gravity down the inclined conveyor to a waiting truck. After all packages for a train have been accumulated on the truck, the mail is carried to the outgoing train and loaded aboard.

▸ Scope of Application

The Pennsylvania Railroad sortation system consists of only one main conveyor with transfer mechanisms which push the parcels onto 39 spur conveyors. Several other systems being developed by Stewart-Warner are made up of several belt conveyors and storage mechanisms which will store parcels or mail bags, and then feed them into the system at several points in such a way as to keep the system loaded to capacity. The electronic system described is easily adaptable to handle the more sophisticated systems of this nature by the addition of buffer storage units at each additional feed point of the main system. This enables the electronic system to control many sorting problems which are not being handled automatically today because of their complexity.

In the Philadelphia installation it was convenient to place the parcels with their centers spaced approximately on 3-foot intervals, and the system is designed on this assumption. However, in some cases, it would be more desirable to feed the packages on a conveyor belt with a minimum spacing between parcels. In a system designed for this type of operation, photoelectric cells could be added at each station to set the timing for a given package. In addition, package length measuring circuits could be incorporated into the system at the beginning of the sortation area.

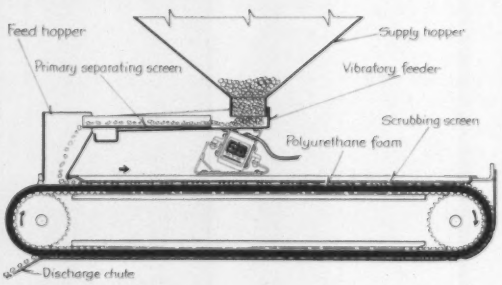
The control panel, *Fig.* 6, for the Pennsylvania system is composed of many rows and columns of transistorized plugboards. Such construction makes it possible to construct systems of various sizes and characteristics by using the same basic plugboards and combining them in different ways for particular installations. This combines high versatility with long life and reliability to make a successful approach to the problem of large sorting systems.

blanching machine removes skins from nuts

INTERESTING machine introduced by Jet-Heet Inc. combines a vibratory feeder and a polyurethane foam belt to remove skins from nuts without marring or damaging the nut surfaces.

Nuts from a supply hopper pass into the tray of an Eriez Mfg. Co. vibratory feeder which causes the nuts to advance over a primary separating screen. This action screens out the skins that have been loosened by agitation in the vibratory feeder. The nuts then drop into a second hopper and feed onto a moving belt of resilient polyurethane foam. This belt rolls the nuts against scrubbing screens of expanded metal and woven wire and delivers the nuts to a discharge chute with skins removed.

Potentiometer control of the vibratory feeder assures uniform distribution of the nuts over the scrubbing belt and provides variable feed rates ranging up to 400 pounds of nuts per hour.



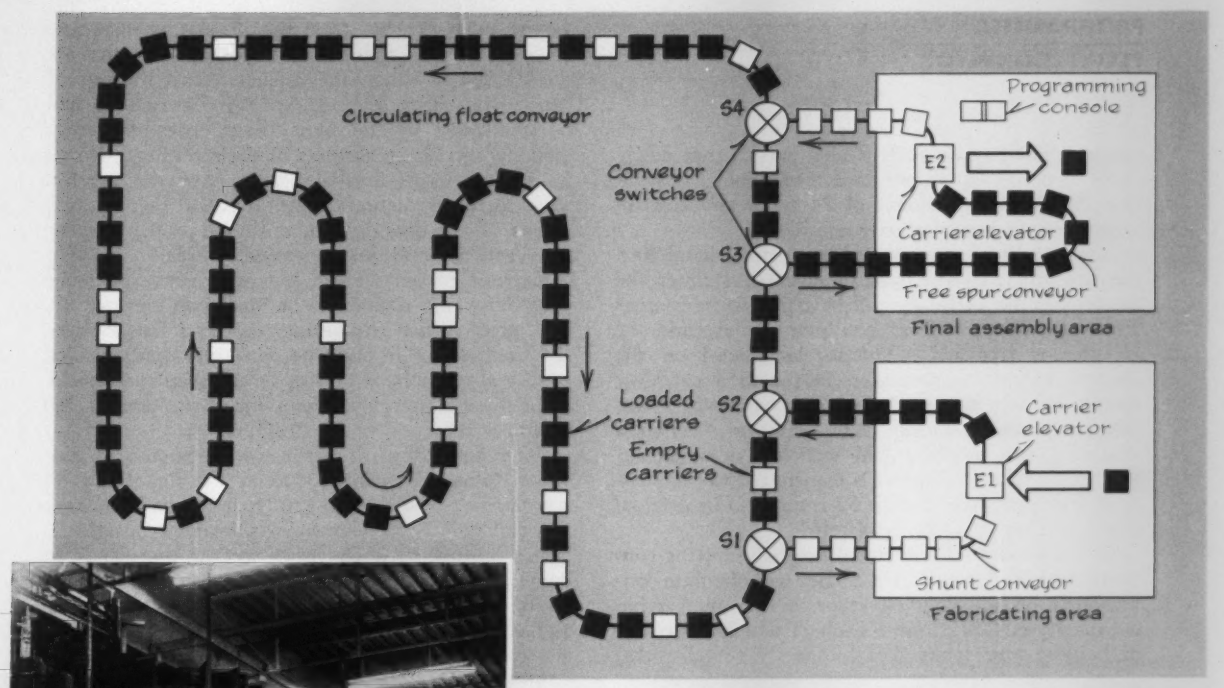


Fig. 1—Schematic plan view of overhead conveyor system designed and built by Mechanical Handling Systems Inc. illustrates flow paths for loaded and unloaded carriers. Water heater tanks of two types in various sizes are loaded on carriers in fabricating area and transferred automatically to continuously circulating float conveyor, inset. Programming console is set to automatically remove desired tanks from float conveyor and deliver them to assembly area. Elevators in both work areas facilitate handling of product to and from conveyor system. Carriers that are unloaded in the assembly area are automatically replaced on the float conveyor and can be shunted to the fabricating area for loading.

PROGRAMMED FLOAT CONVEYOR

CO-ORDINATES FABRICATION AND ASSEMBLY

By **TED BOTTIGGI,** Chief Mfg. Engineer, Day & Night Mfg. Co. and Payne Co., Div. Carrier Corp., La Puente, Calif.

AN OVERHEAD, circulating float conveyor has enabled co-ordination of a multishift fabricating operation with a single shift final assembly routine at the combined facilities of Day & Night Mfg. Co. and Payne Co., La Puente, Calif. Both companies are divisions of Carrier Corp.

Water heater tanks are fabricated in two shifts at a rate of 700 tanks per shift. These are incorporated in final assemblies in a single shift at the rate of 1400 tanks per shift. The circulating float conveyor receives all production from the fabricating shop and delivers it as demanded by the assembly shop.

In operation of the system, *Fig.* 1, galvanized and enameled tanks are loaded four-at-a-time on carriers delivered to an elevator station, *E1*, in the fabricating area. Similar sizes and types of tanks are loaded together. An operator at the elevator station

PROGRAMMED FLOAT CONVEYOR

sets a signal flag on each loaded carrier that designates its contents. Combinations of signal flag positions permit identification of 24 types and sizes of tanks and an empty carrier condition.

After loading a carrier and setting its signal flag, the operator moves a control lever that raises the carrier on the elevator. The carrier is transferred automatically to a shunt conveyor section, and the elevator is returned. The carrier placed on the shunt conveyor section then moves to a conveyor switch, *S2*, where it waits for an empty space to appear on the circulating float conveyor. When a space becomes available, the switch is actuated automatically and the carrier is transferred to the powered float conveyor. Switch *S2* returns to its original position after transfer is effected.

In the absence of a command signal affecting conveyor switch *S3*, the loaded carrier will circulate continuously on the float conveyor. This conveyor has a capacity of 270 carriers, each of which is capable of holding four tanks. Total capacity (1080 tanks) is ample for the system to supply the continuous operation demands of the assembly area. A small excess provides buffer stocks in the event of temporary stoppages in the supply of tanks from the fabricating area. The overhead location of the float conveyor adds to total floor space that can be used for productive operations.

Because of the diversity of types and sizes of water heaters produced, assembly operations are performed in batch lots. When the assembly line needs a certain type and number of tanks, an operator at elevator station *E2* operates two controls on a programming console. One control denotes the type of tank required, and the other is preset to the desired number of tanks of that type.

When a carrier containing the preselected type of tank reaches conveyor switch *S3*, the signal flag on that carrier actuates the switch. This causes the carrier to be diverted from the circulating float conveyor to a free spur conveyor leading to the assembly area. When the predetermined number of carriers has been diverted, conveyor switch *S3* will be unaffected by the signal flags on subsequently arriving carriers, regardless of their settings. Switch *S3* returns to its normal position between carriers so as to require actuation by the signal flag on each carrier of the type desired, until the proper number has been diverted to the assembly area.

Carriers placed on the free spur conveyor move by gravity into position to be loaded on elevator *E2*, and stop. When the elevator is in its *Up* position, the first carrier in the line is automatically loaded on the elevator by a pusher arrangement. The elevator then descends to its *Unload* position in the assembly area.

After unloading a carrier, the operator at elevator station *E2* manually resets the signal flag on the carrier to indicate an empty condition, and raises the carrier on the elevator. The empty carrier is then shunted to a conveyor section that leads to conveyor switch *S4*. Upon its arrival, the carrier waits at switch *S4* until an empty space appears on the circulating float conveyor. When this occurs, the carrier is automatically transferred to the float conveyor by action of switch *S4*.

As the circulating, empty carrier approaches conveyor switch *S1* in the fabricating area, its signal flag may actuate *S1*, causing the carrier to transfer to the shunt conveyor leading to elevator station *E1*. If the shunt conveyor is full, however, an interlock arrangement will prevent the actuation of switch *S1* and the empty carrier will continue to circulate on the float conveyor. A similar interlock arrangement is provided at switch *S3* so that the free spur conveyor for the assembly area will not overfill.

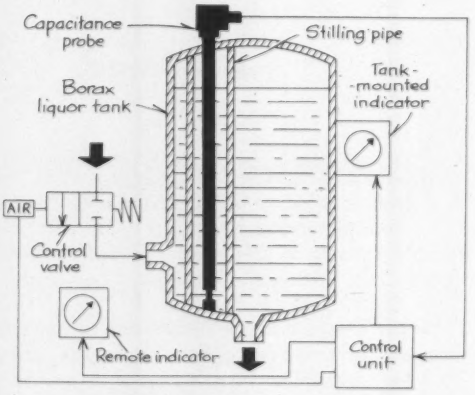
Use of a circulating float conveyor to store a variety of product types, and a programming console for selective retrieval of desired items, ensures that the assembly area will be provided with the right parts, in the correct order, when needed. Applications of this system to other products and other fields are readily conceived.

capacitance probes sense liquid levels

LIQUID LEVEL is maintained automatically in processing tanks at United States Borax & Chemical Corp., Borax, Calif., by a valve control system that employs capacitance probes to sense levels of borax liquor in the tanks.

The system, which uses Robertshaw-Fulton Controls Co. components, continuously senses the liquid levels in the tanks and actuates indicators on the tanks and at a remote control location. When the level of borax liquor in a tank drops below a preset point, a signal from the capacitance probe for that tank causes a control unit to generate an air signal. This signal operates a control valve that admits raw product to the tank. When the level in the tank is restored to normal, the air signal is removed and the valve closes.

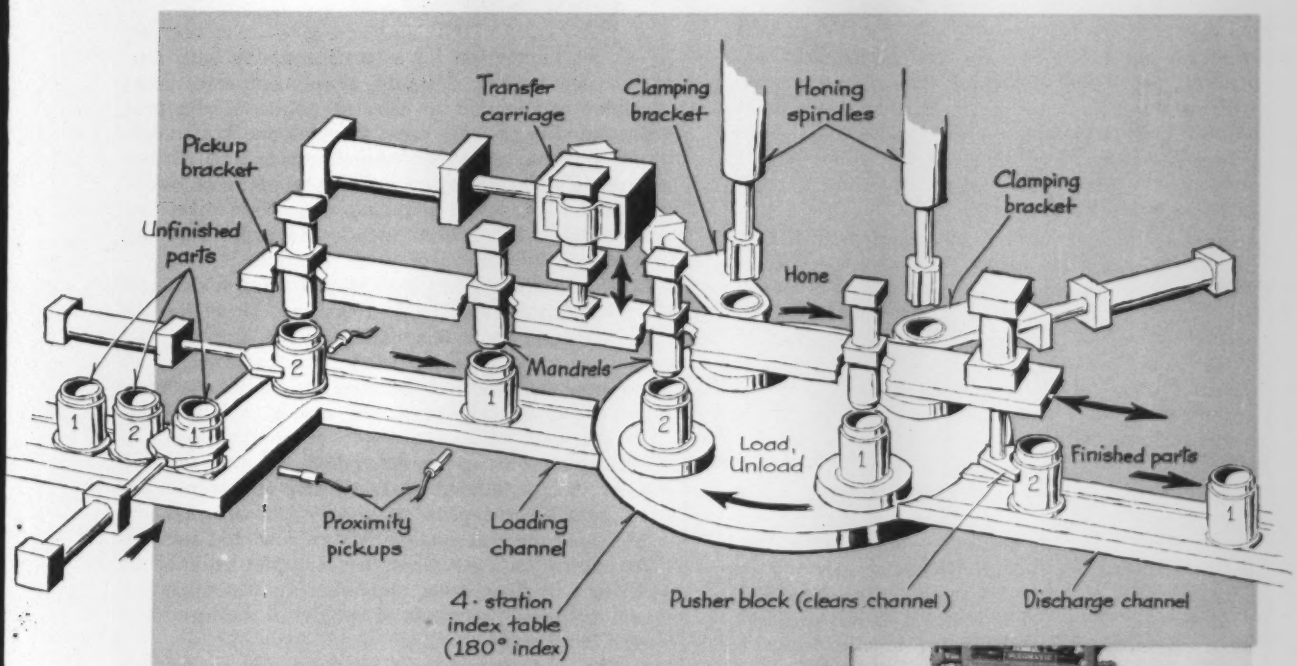
The capacitance probes are encased in vertical stilling pipes inside each of the tanks. Purpose of the stilling pipes is to prevent the generation of false level signals by the probes due to agitation of the liquid in the tanks.



HANDLING EQUIPMENT IMPROVES AUTOMATIC HONING OPERATION

EQUIPPING a machine tool with automatic handling devices provides two important effects: The basic machine can be operated as an integral part of a manufacturing line, and inherent production capabilities of the machine are more easily realized. A recent example is to be found in a vertical type, two-spindle honing machine, manufactured by Barnes Drill Co., which was equipped with a special handling and fixture assembly.

The workpiece is a cast iron cylinder sleeve, approximately 3 inches in diameter by 5 inches long, from which 0.002-0.004 inch of stock is removed in finishing the cylinder bore within a range of 25-35 microinches, rms. The sleeves are honed at the rate of 144 parts an hour at 80 per cent efficiency; geometric accuracies of better than 0.005 inch for roundness and taper, and bore sizes consistently within 0.0007 inch tolerance, are obtained.



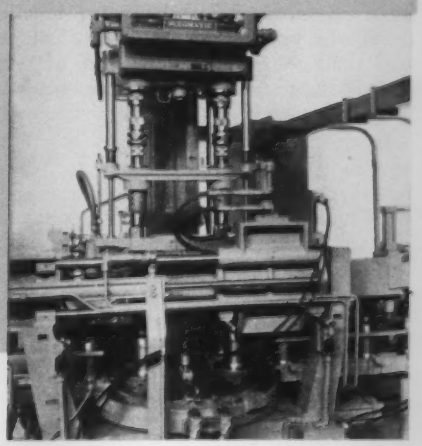


Fig. 1—Vertical-type, two-spindle honing machine finishes 144 parts per hour at 80 per cent efficiency. As shown in diagram, hydraulic cylinders provide actuating means to move parts into loading position, to load and unload index table, and to clamp parts under honing spindles.

The machine tool is equipped with controls that provide automatic expansion and collapse of the hone, adjustable hone feed, automatic compensation for stone wear, and individual feed for each spindle. Sizing control units allow independent spindle honing action until bore size is reached. The machine controls are electrically interlocked with cyclic operations on the handling equipment.

Basic assemblies of the handling system are an index table and a transfer carriage—both of which are mounted on a stationary fixture table. Generally speaking, the design of the system provides for honing two cylinders at a time; at the end of the machining cycle, the worktable indexes through 180 degrees, removing the two finished cylinders and placing two unfinished cylinders into machining position. Simultaneously with the subsequent honing operation, the transfer carriage removes the two finished parts from the index table and loads two unfinished parts into the vacated fixtures, *Fig.* 1.

Parts are supplied upright to a short preload conveyor extension which can hold three parts. A proximity switch senses the presence of the lead part and causes a hydraulic cylinder to operate, pushing the part onto the loading channel. The presence of the lead part before another cylinder is sensed by a second proximity switch and this cylinder is actuated, pushing the workpiece to the forwardmost position on the loading channel. The second part is then transferred from the extension to the loading channel and the proximity switches signal that two parts are in loading position.

Loading is accomplished by a transfer carriage, capable of lateral movement, that supports a horizontal pickup bracket on a vertical slide. Four cylinder actuated pickup mandrels suspended from the pickup bracket are arranged in two pairs. Mandrels in each pair are spaced apart a distance equal to center distance of the two unhoned parts on the loading channel. This spacing is also equal to the center distance of two fixtures on the index table.

With the transfer carriage in its extreme left position, the pickup bracket lowers at a signal, positioning the mandrels in the cones of the two unhoned parts and two previously honed parts held by the fixture. The mandrels expand, gripping the parts, and the pickup bracket rises. Simultaneously with this action, a cylinder actuated pusher block, mounted on the end of the pickup bracket nearest to the discharge channel, descends. This pusher block will clear the discharge channel of previously deposited honed parts on the channel as the transfer carriage moves to its extreme right position.

In this latter position, the pickup bracket lowers and the pickup mandrels collapse, placing the unhoned parts in the vacated fixtures on the index table and the honed parts in the discharge channel. The pickup bracket then rises to clear the parts.

At no time during normal operation is the operator required to do anything other than change the honing stones when indicated by the control panel. It is worthwhile to note that the two-spindle automatic machine maintains the production quota of three manually loaded and unloaded single-spindle machines previously used to hone the parts.

SELECTIVE MECHANIZATION CUTS COSTS ON FOOD PROCESSING LINE

AUTOMATING an entire production line can be impractical for a small company with limited capital. Usually, these companies must employ automation at selected points in the production line to alleviate troublesome bottlenecks and operational kinks where costs are high but potential sales volume warrants some form of mechanization. Such an approach has been taken by Myers Food Inc. to reduce costs and improve quality in a prepared frozen food production line.

Many steps are involved in producing high quality, uniform frozen food croquettes. These include the accurate measuring of ingredients, pressing and shaping to uniform size and shape, soaking in an egg-milk mixture and draining off the excess, coating the croquette with bread crumbs, and cooking. In the case of Myers Food, manual methods of making croquettes would require 80 operators to meet their estimated peak demand and would necessitate a large plant to house such an operation. In improving this process, Myers Food has invested its capital in a machine that occupies only 15 by 40 feet in floor area, requires only two operators, and produces thousands of croquettes that are identical in all ways.

The croquette making machine, *Fig.* 1, is fully automatic once the operator has filled the loading hopper. A pneumatically controlled auger feeds the croquette ingredients from the hopper, through a piping system, and into a molding head where a carefully metered quantity is formed and pressed into croquettes, two-at-a-time. The units are then deposited into individual chambers for soaking in an egg and milk mixture.

After soaking, the croquettes are dropped onto a wire-mesh conveyor belt that carries them to a revolving breading tank. Any excess egg and milk mixture drains off into a receiving tank as the

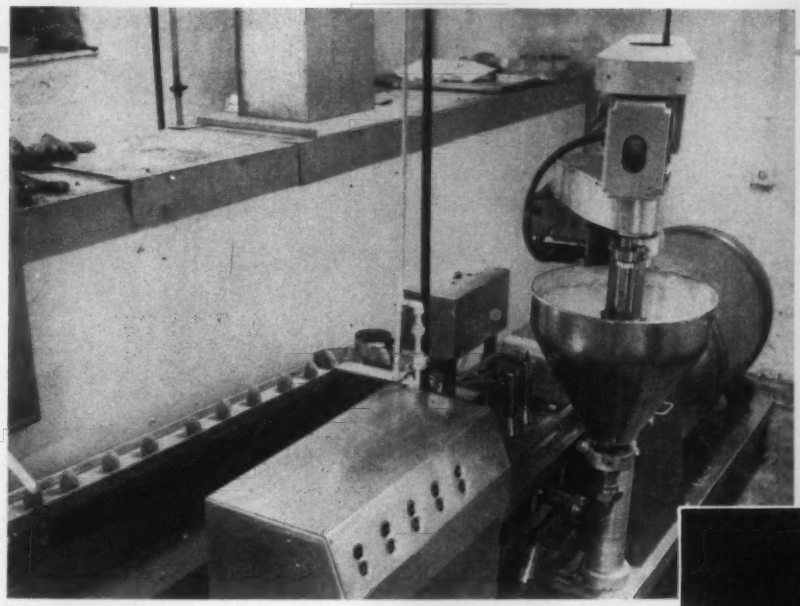


Fig. 1—Machine for automatically making frozen food croquettes is an example of process improvement applied by Myers Food Inc. Operator loads ingredients into large hopper from which an auger feeds material to a molding head. Conveyor carries croquettes to revolving breading tank at right which applies crumbs and deposits the breaded units on another conveyor. Conveyor on left then carries the croquettes to the baking oven in the center background.

units are conveyed. After coating the croquettes, the breading tank lifts and deposits the units onto a second wire-mesh conveyor located over the top of the first conveyor. Excess crumbs are removed from the croquettes by a crumb blower supplied with oil-free air. A series of orifices in two copper tubes directs compressed air onto the units from above and below the conveyor belt. The croquettes are then conveyed through an oven for cooking.

A second example of process improvement occurs at the start of a meat pie line. In this case, the bottom tray from a tightly-stacked pile of aluminum containers is separated by cam and pneumatic action, *Fig.* 2. Revolving cams cannot separate the bottom tray from the stack without damage since tight stacking causes the formation of a slight suction between trays. By timing the air blast to coincide with the cam action, the suction is broken, and the tray is firmly positioned on an elevated platform. After the platform is lowered automatically, another timed air blast slides the tray off the platform, down a chute, and to an automatic gravy dispenser.

An essential part of the production line improvements are two separate compressor systems supplied by Ingersoll-Rand Co. One system supplies oil-free air that can be used in direct contact with food products, and the other system is used for actuating mechanical functions. By designing both pneumatic systems with an open-end, no automatic controls or unloading devices are required. Any pressure buildup merely increases the volume of air used for crumb blowing or tray positioning.

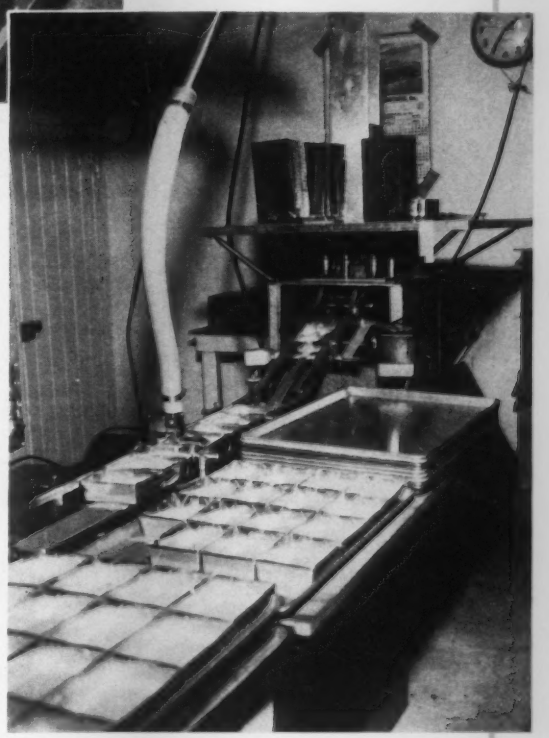


Fig. 2—Timed air blasts break suction on bottom tray in stack at the start of the meat pie line. Revolving cams then position the tray on an elevated platform which lowers to the head of the inclined chute. A second air blast propels the tray into the chute and onto a moving conveyor belt. As the trays pass a photoelectric cell, an overhead mechanism is actuated and dispenses a measured quantity of gravy into each tray. Trays are then loaded into pans for manual loading of the remaining ingredients of the pie.

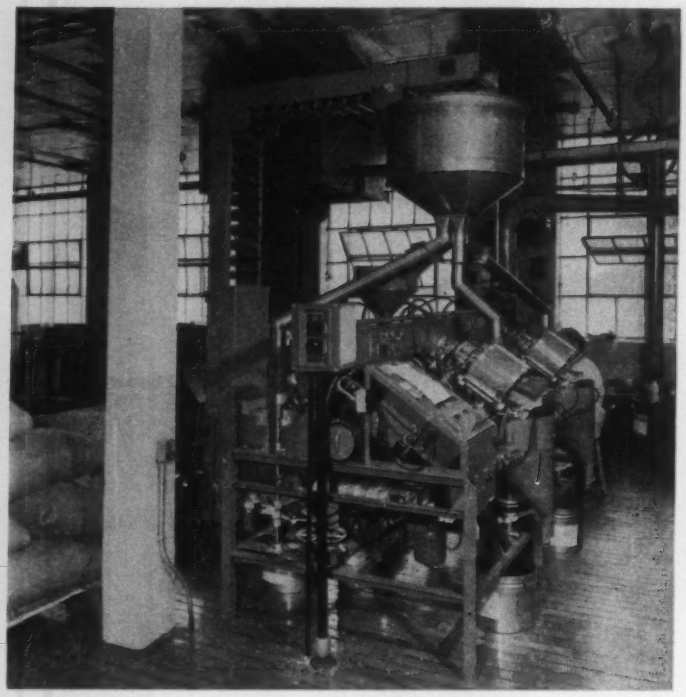


Fig. 1 — Electronic peanut sorter, fed from bucket elevating conveyor, automatically inspects multiple lines of peanuts passing by inspection heads. Unit ejects discolored nuts and foreign material from product streams.

PACKAGING EQUIPMENT SELECTION

FITS LONG-RANGE PLANS

MANAGEMENT POLICY at Wayne Candies Inc., Fort Wayne, Ind., with respect to automation of their candymaking operations can be expressed in one concise statement: "We never buy a piece of equipment—we buy a solution to a problem." In common with hundreds of other concerns, both large and small, this company is faced with constant pressure to speed operations and cut costs. That means automation. However, it is seldom feasible for them to scrap existing facilities and replace them with complete, new automatic systems. The automation program, therefore, is based on solving manufacturing problems as they arise and supplying partial automation where it can be integrated into existing operations. Each solution must meet two tests: 1. It must be capable of introduction with minimum interruption of production. 2. It must fit in with long range automation plans.

Problem Solving Technique

First step in problem solving is a thorough analysis of the existing method and where it falls short. Next, general aims and requirements for an improved method are outlined. In the final step, Wayne Candies has learned to resist the temptation to call for quotations on machines that seem to fill specifications. They recognize that their knowledge of equipment may not always provide the best answer; so they limit their recommendations to "avenues of approach."

Since most of the candymaking operations involve

handling, inspecting, and packaging, the information gathered in the three-step problem solving analysis is usually turned over to firms that specialize in these fields. This is where specific equipment recommendations come from. All of the incoming suggestions are then examined for economy, efficiency, present adaptability, and future potentiality. Results of the problem solving technique can be illustrated with specific examples of its application.

▶ Peanut Sorting

Quality control is a vital aspect of all of the processing operations carried out in the candy plant. For example, every batch of shelled peanuts used must be carefully sorted to remove foreign matter and imperfect nuts. The problem solving outline worked up for this operation was: 1. *Existing method*: Visual inspection. 2. *Where existing method falls short*: Sorting costs increase directly with volume; mass production economies cannot be made. Employment of humans for the inspection function means that some imperfect product will be passed. 3. *General aims and requirements*: Greatly increased sorting rate, preferably obtained by mechanized means that will free skilled help for more valuable work.

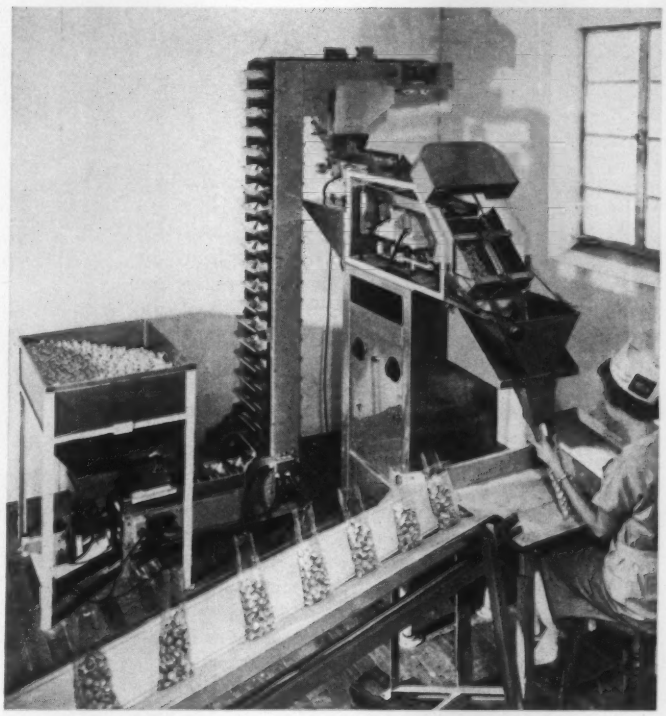


Fig. 2—Automatic weighing machine measures predetermined quantities of candies and releases them to bags held in place by operator. Bucket elevator conveyor feeds candies to weigher and belt conveyor delivers filled bags to labeler.

As their first avenue of approach, Wayne personnel investigated an electronic peanut sorter, *Fig.* 1, made by Electric Sorting Machine Co., Houston, Tex. This machine employs multiple inspection heads each of which electronically checks peanuts passing by in single file. Any imperfect item in a line, such as a discolored nut or a piece of foreign matter, is automatically diverted from the line. Since the requirements of greatly increased sorting speed and mechanized operation could be met with this equipment, its acquisition was approved.

However, one problem remained—that of maintaining the proper feed levels in the machine's overhead hopper. By traditional methods, this would require the assignment of a full-time operator, and partially negate the advantages of the automatic inspection machine.

The solution adopted was to couple a bucket elevator conveyor, *Fig.* 1, built by Lynch Corp., Anderson, Ind., to the feed hopper of the peanut sorting machine. A floor-level hopper, which can be supplied with noncritical amounts at infrequent intervals, was provided to fill the buckets of the elevating conveyor. Timing controls ensure that the buckets are not overfilled with peanuts, and level control switches in the inspection machine overhead hopper start and stop the elevating conveyor to maintain proper peanut levels.

As a result of carrying through a problem solving analysis in this phase of candymaking, labor costs were reduced 66 per cent over the former visual inspection method. Peanut quality has also been improved greatly by the substitution of electronic for human inspection means.

▶ Weighing and Bagging Candies

Cost studies revealed that packaging of one candy product was more expensive than for most other items. The problem: When handled roughly, the candy tends to break, leading to material losses and, more importantly, time losses while handling equipment is cleaned of candy chips. In addition, because the candy is a seasonal item, any automatic equipment would have to be relatively inexpensive and able to handle a number of other candy items. The problem solving analysis indicated the following: 1. *Existing method*: Includes manual weighing and bagging. 2. *Where existing method falls short*: Costly, inefficient, slow, results in breakage of candy. 3. *General aims and requirements*: An inexpensive automatic weighing device that will handle product gently. Equipment selected should be adaptable to handle a variety of candies.

Two Lynch Corp. products—a bucket elevating conveyor and an automatic weighing machine—proved a solution to this problem, *Fig.* 2. The bucket elevating conveyor receives candy from a supply hopper and conveys it gently to the weighing machine. A vibratory feeder conveys the candy to a

Fig. 3—Candy bar wrapping layout provides for future expansion by addition of wrapping stations at sides of conveyor lines. Bars conveyed from cooling tunnel are picked up by wrapper operators, inspected, and wrapped automatically. Manually filled cartons are placed on central conveyor for transport to shipping area.

sloped weighing bucket. The vibratory feeder is divided into three sections—two bulk feed channels and a central dribble feed channel. This arrangement provides a means of rapidly supplying an accurate amount of candy to the weighing bucket. Interchangeable discharge spouts can be fitted to the machine to fill different types of bags. Weight controls are readily adjusted to requirements.

With this weighing and bagging arrangement, packaging labor costs have been reduced by 10 per cent. Material losses have been reduced approximately 50 per cent, and quality has improved. Adaptability of the weigher to receive a turret table makes possible a future increase in capacity of 400 per cent.

▶ Wrapping Candy Bars

The candy bar wrapping problem was not so much that of finding suitable automatic equipment as it was in laying sound plans that would enable expansion of product volumes without interruptions to production. An efficient plant layout was an essential element in the solution of this problem.

In the arrangement devised, *Fig.* 3, candy bars are removed from a cooling tunnel and conveyed past a series of wrapping machine stations. At each station, a wrapper operator removes bars from the conveyor, inspects them, and places them in the wrapping machine. At the discharge side of the wrapping machine, a second operator manually cartons the bars and places the cartons on a central conveyor mounted above the supply conveyor. The central conveyor moves the cartons to a shipping area. Wrapping stations are placed on both sides of the conveyor arrangement for maximum utilization of equipment and floor space.

Problem solving techniques applied to this operation have made possible ready expansion of production with minimum inconvenience. It is necessary only to add wrapping stations as requirements increase. To meet seasonal demands, as many wrapping stations as required may be assigned to handle a particular product.

Partial automation of operations—preceded by careful planning—is the key whereby many other companies can acquire automatic equipment now that can gradually be integrated into an automated production system.

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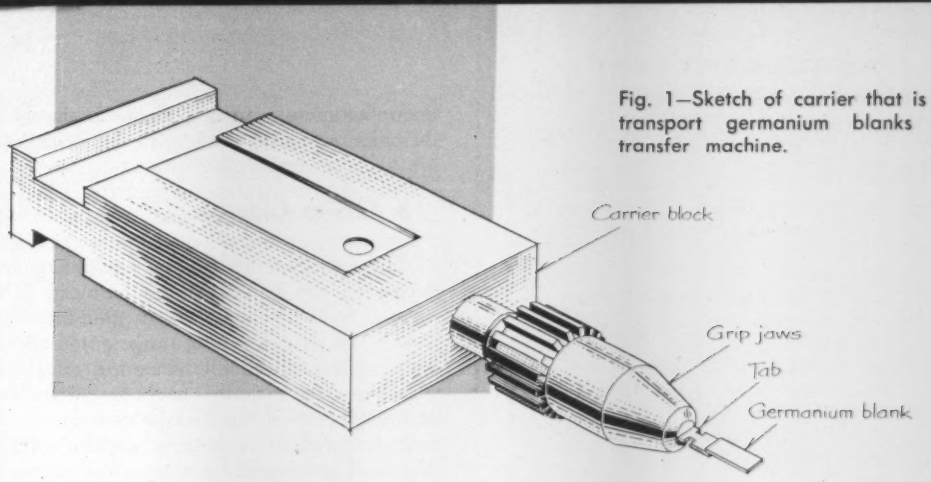


Fig. 1—Sketch of carrier that is used to transport germanium blanks through transfer machine.

AUTOMATED TRANSISTOR PRODUCTION

Automation is destined to put the transistor in the entertainment industry. An integrated engineering approach of product, process, and equipment design can present a better product to the marketplace at lower cost.

PRODUCTION techniques play a big role in the commercial development of new products. One place where this fact is pointedly illustrated is in the development of the transistor—one of the fastest growing products in the booming electronics industry. The origin of the product dates back ten years. From the beginning it has appealed to electronic circuit designers as a likely successor to the vacuum tube. It is smaller, more rugged, and consumes less power than the vacuum tube, but it costs more money to make.

Many companies that make electronic devices have been active in the development of production techniques to bring down the cost of the transistor, so that they might participate in the promising market expansion foretold by the potential of the product. One answer to the problem of how to produce transistors in quantities that would make them readily available for all the roles they can fill, was provided by Philco Corp. in 1953 with the announcement of its Surface Barrier Transistor (SBT). This high frequency transistor could be produced in quantities using electrochemical techniques. The SBT project benefited from military contract assistance, and the result was a rugged and reliable product, but it was not the whole answer.

About four years ago researchers and equipment designers at the company's Lansdale Tube Co. division were put to work on a project known as the "F.A.T." line. The initials stand for Fast Automatic Transfer. The purpose was to design and build a series of machines that would utilize automation as far as possible to produce Micro Alloy Diffused Transistors (MADT) of high quality at increased production rates and low cost—transistors destined for the entertainment industry (see box). The result is now in operation and consists of a series of machines which require nine operators and can put together 450 transistors an hour. The F.A.T. line does not obsolete all other methods of transistor production, but it has enabled the company to announce significant price reductions. Example: MADT, 2N499 in quantities of 100 or more now priced at $3.50, formerly $5.50.

Integrated Engineering

The engineering talents that developed the F.A.T. line are part of a 300 man engineering organization that consists of three subdivisions: 1. Product Design. 2. Factory Engineering. 3. Equipment Design.

Because variables in the manufacturing process so directly affect the characteristics of the product these three engineering subdivisions must work in a highly co-ordinated manner to produce satisfactory results. All report to the Director of Engineering. The development of the process, and each step of the

PROCESS SEQUENCE CHART

Manual	Auto	Description
1a		Loads Tab into Carrier
1b	1b	*Solders Germanium Blank to Tab
1c		Checks Tab Position
	2	Precisely Measures Blank Thickness
	3	Etches Collector, Controlled by Thickness Measurement
	4	Etches Emitter
	5	Rinses
	6	Plates Emitter and Collector
	7	Rinses
	8	Dries
	9	Tests Diode Breakdown
	10	Attaches Emitter Whisker and Micro-Alloys
	11	Rinses and Dries
	12	Rolls Carrier Over
	13	Attaches Collector Whisker
	14	Rinses and Dries
	15	Electrolytically Etches to Clean-up
	16	Quench Rinses
	17	Rinses Ultrasonically
	18	Long Rinsing
	19	Long Drying
20a	20a	Welds Tab to Stem Lead
20b	20b	Shears Excess Tab
21	21	Welds Both Whiskers to Respective Stem Leads
22		Loads Vacuum Oven From Dust Shield
	23	Unloads Vacuum Oven into Dry Box
25	25	Tests For I_{co} and I_{eo}
26	26	Cold Welds Top to Stem

*Operation sequence numbers when shown in both columns represent stations that are tooled to perform the work, but require manual operation of the tooling.

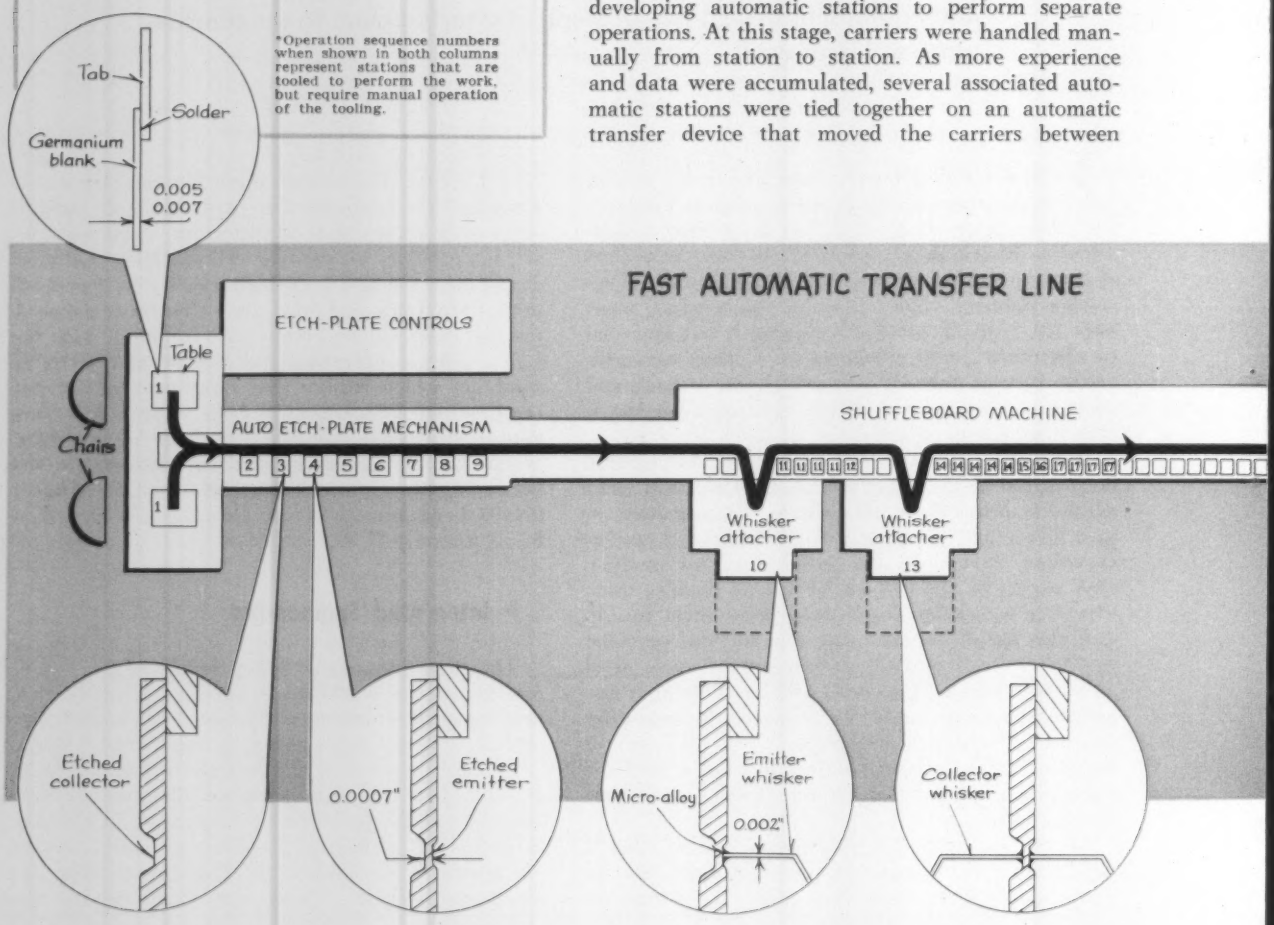
manufacturing sequence, must be closely controlled in order to satisfy product design specifications.

▶ Carrier Concept

The specifications for the equipment design were based on the nature of the business. It had to be flexible to allow for changes and improvements. It had to be part of a long range automation program, so that the parallel engineering effort could continue, and the machines could be designed to produce transistors while the transistors themselves were being designed. It had to be capable of transferring the work-in-process from operation to operation with extreme precision. It had to be high speed in order to keep costs low.

To satisfy these specifications the equipment design evolved around a "carrier concept." A carrier is an accurately machined stainless steel block that is fitted with grip-jaws which position a germanium blank, *Fig.* 1. Each blank in process is held by a carrier and can be precisely positioned in a workstation by locating reference surfaces on the carrier. The carrier serves as a movable fixture. It fits all workstations that process the blank, and as such it is the common denominator in a "building block" philosophy of machine design.

First phase of the equipment design consisted of developing automatic stations to perform separate operations. At this stage, carriers were handled manually from station to station. As more experience and data were accumulated, several associated automatic stations were tied together on an automatic transfer device that moved the carriers between



stations. Machines created in this manner were then tied together with feed conveyors to form a line. The last step in the automation development was the establishing of control points to make it possible to correct for deviations in product performance by feeding back information to earlier operations.

Manufacturing Process

At Stations 1 the germanium blank, which has been previously sliced from an ingot and measures approximately 1/8 inch by 3/16 inch by 5 to 7 mils thick, is soldered to a tab that is fastened in the carrier. The tab is manually loaded into the carrier. Blank and carrier are manually positioned into a soldering fixture. After one operator completes the soldering operation another inspects the tab position with an optical comparator and places the carrier on a belt conveyor that supplies an in-line transfer machine, *Fig.* 2. Station 2 automatically measures blank thickness and gives this information to the control system of Station 3 where the electroetch cycle length is varied in accordance with the thickness of each blank. This etching operation of Station 3 is performed on what is called the collector side of the blank and it creates a small circular pit in the center of the blank's surface. Purpose of the cycle control is to keep constant the wall thickness remaining between the bottom of the pit and the reverse side of the blank.

Station 4 performs a similar, but shallower etch operation on the reverse side of the blank (called the emitter side). This is a constant etch cycle because of the control at the previous stations. At this stage

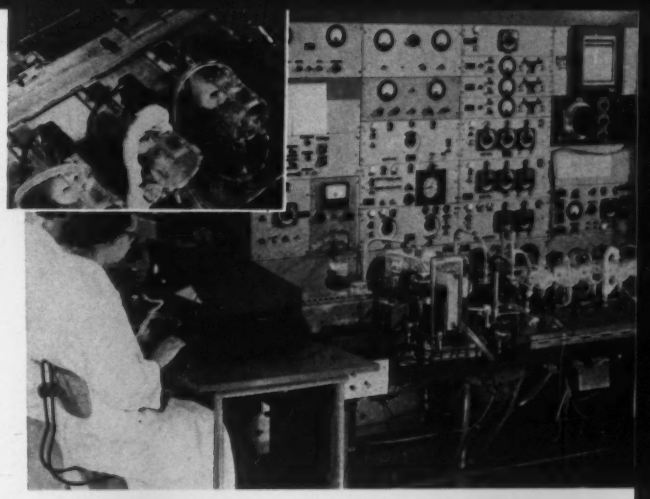
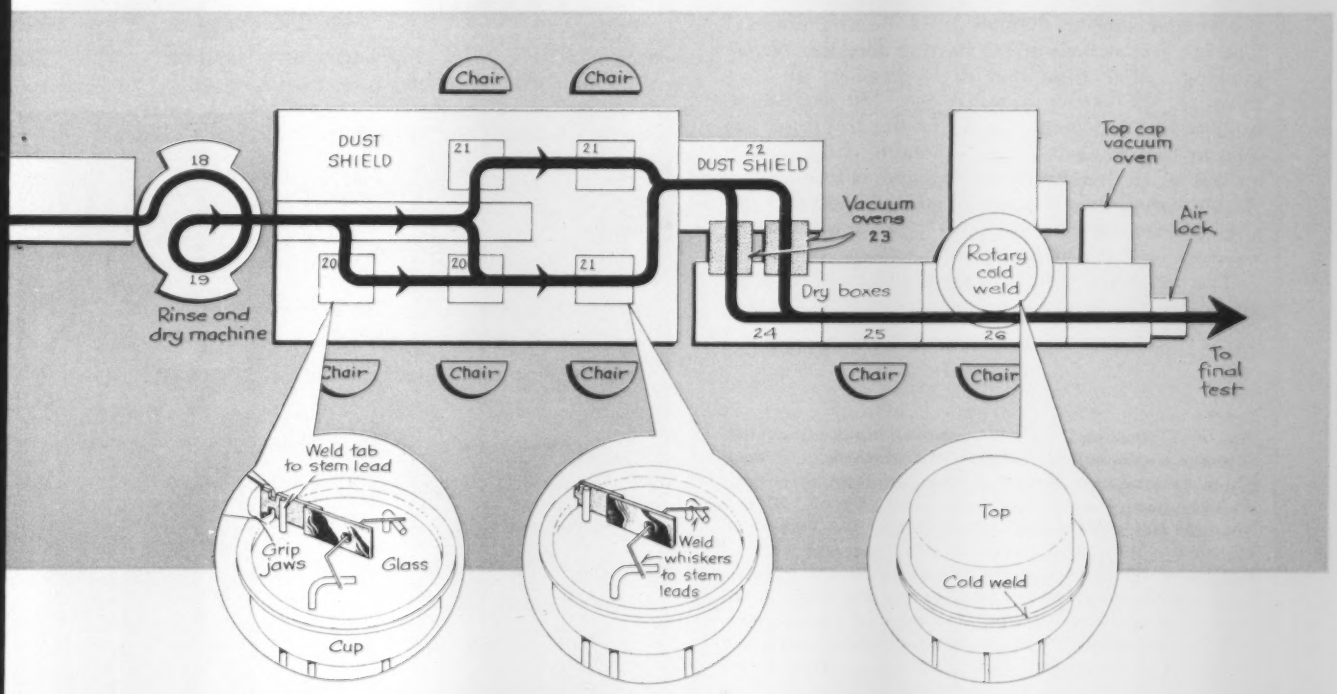


Fig. 2—Start of Philco transfer machine line used to make transistors. Operators load tab to carrier, solder blank to tab and inspect position. Transfer machine automatically etches and plates blank. Inset shows closeup of workstations.

the wall thickness between etches is 0.0007 inch. Station 5 rinses the etch solution from the blank and Station 6 plates both sides of it. Stations 7 and 8 are rinse and dry respectively, and Station 9 makes a test of diode breakdown.

Stations 2 through 9 constitute the etch-plate part of the process and are all linked by a transfer bar mechanism, *Fig.* 3. Longitudinal and cross transfer actions move carriers from input conveyor, successively to each workstation, and to outlet conveyor.

Transferring of carriers is accomplished in like fashion on the next machine in the process. This machine is known as the "shuffleboard" machine,



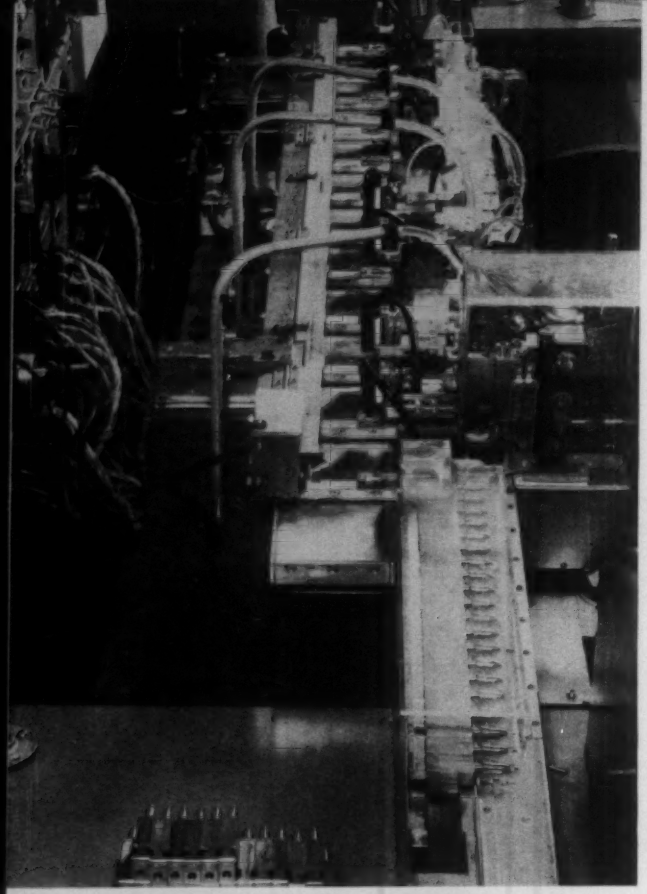


Fig. 3—Over-all view of automatic etch-plate machine in the transistor manufacturing line shows workhandling arrangement. Carriers on which the blanks have been loaded must be successively moved into each of the workstations at right in the photo. Loaded carriers are fed to a longitudinal transfer bar by conveyor in foreground. A cross bar pulls the carriers into pockets on the transfer bar; the transfer bar advances; the cross bar pushes the carriers off the transfer bar and into the workstations; and the transfer bar retracts. A second conveyor takes the carriers to further processing in the background.

Fig. 4, and its purpose is to attach whisker wires (2 mils in diameter) to each side of the germanium tab. At Station 10 a whisker is formed and cut off and dipped in a molten indium alloy then attached to the emitter side of the tab, by a heating process. The last few seconds of the heating does the microalloying. After rinse and dry operations at Stations 11, the carrier is rolled over 180 degrees at Station 12. Automatic testing of the transistor for gain as well as diode curves is done to check on the success of the emitter attaching and microalloying. A setup similar to Station 10 puts the whisker on the collector side at Station 13. This is followed by rinse and dry at Stations 14.

The assembly is then electrolytically etched to clean it up at Station 15, quench rinsed at Station 16, and rinsed ultrasonically at Stations 17. At the end of this machine the carrier is automatically transferred to a 72-position rinse and dry machine which is rotary in shape to conserve floor space. (Stations 18 and 19.)

The next machine, *Fig.* 5, has manually operated workstations. At the first of these, Station 20, the operator welds the tab to a lead on a stem subassembly. The stem subassembly consists of a cup-shaped base and three leads positioned in a glass insulator that almost fills the cup. This subassembly is made elsewhere in the plant and not on this line. After welding, the operator removes the tab from the carrier and shears off the excess tab. At Station 21 the operator welds both whiskers to their respective stem leads. To provide for simultaneous production of transistors having different styles of stems, Stations 20 and 21 are equipped for multiple setups. To ensure cleanliness, so necessary to the manufacture of a successful transistor, these workstations are protected by a dust shield arrangement that puts a flow

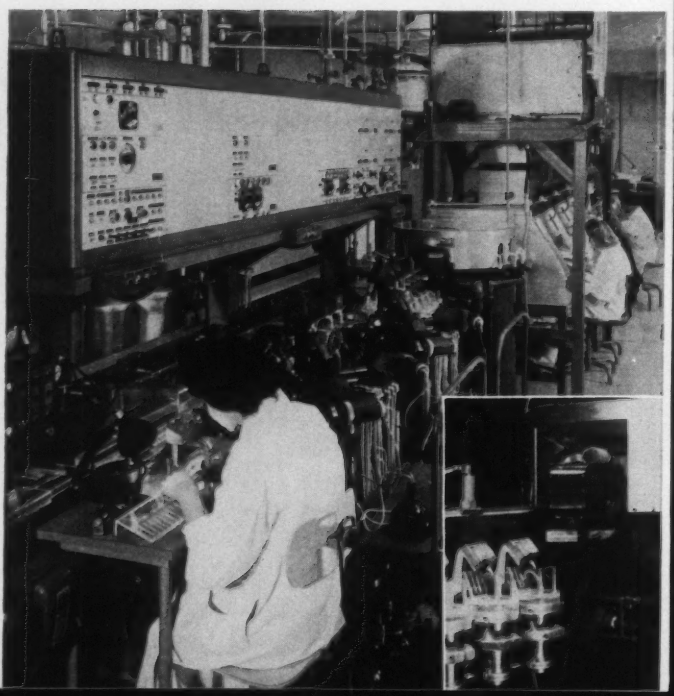


Fig. 4—Outlet end of automatic etch-plate machine supplies beginning of Shuffleboard Machine. At time photo was taken, whisker attaching stations of a preliminary design were operating at the rate of 150 per hour on the shuffleboard machine and the etch-plate machine was operating part-time at the rate of 450 per hour. Operator here was performing the transfer between machines which became an automatic function when new whisker attaching stations of the faster rate were installed. Inset shows ultrasonic cleaning stations and transfer to rinse and dry machine.

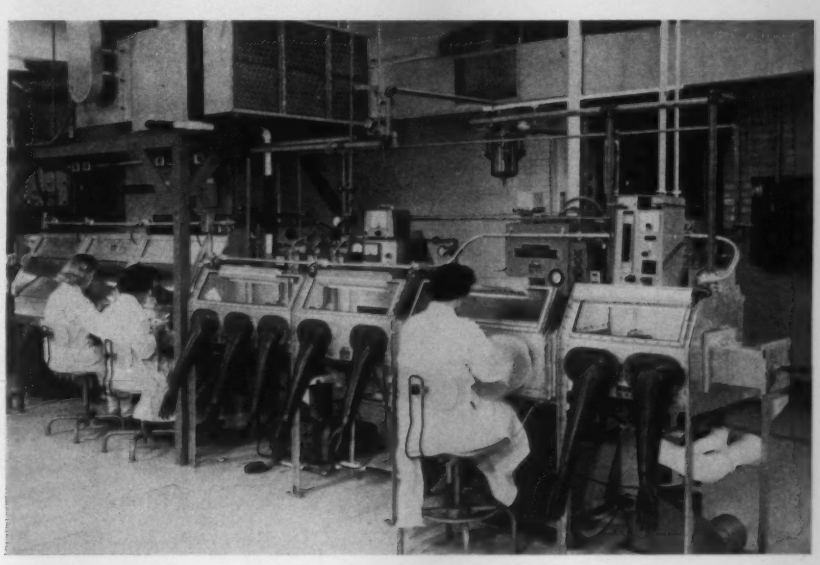


Fig. 5—Dust-shield and dry-box areas of line include manual stations for lead weld and test and cold weld assembly press.

of filtered and electrostatically cleaned air over the work-in-process.

As the workpieces are completed at Station 21 they are placed in pallets which are in turn loaded into a vacuum oven to ensure that no moisture remains on any of the surfaces of the assembly. When these pallet loads are removed from the vacuum oven they remain in a dry box and all subsequent operator contact in the F.A.T. line is accomplished through long rubber gloves at Stations 24 through 26. At Stations 25 tests are made for diode characteristics, and at Station 26 a cap is assembled to each transistor and cold welded to the stem. This operation seals in the atmosphere where the germanium will remain for the rest of its useful life.

The cold weld machine is a hydraulic press equipped with rotary index table. Each stem is manually prepositioned in a fixture on the dial and each cover is manually prepositioned on a station above the dial. The machine automatically assembles and presses the two nonferrous materials together with sufficient force to weld the metals.

Transistors are removed from the F.A.T. line through an air-lock at the end of the drybox and are taken to another area for final test.

▶ Major Advancement

Although this automated production line is considered a major advancement in the technique of transistor manufacture, it is just a step in a long-range program.

New transistors are being designed to take advantage of the production methods developed here. New production lines are in the making. Another F.A.T. line is expected to be in operation by the first of April and several more are scheduled.

Creation of a market and creation of the automated wherewithal to supply that market go hand in hand.

TRANSISTORS FOR THE ENTERTAINMENT INDUSTRY

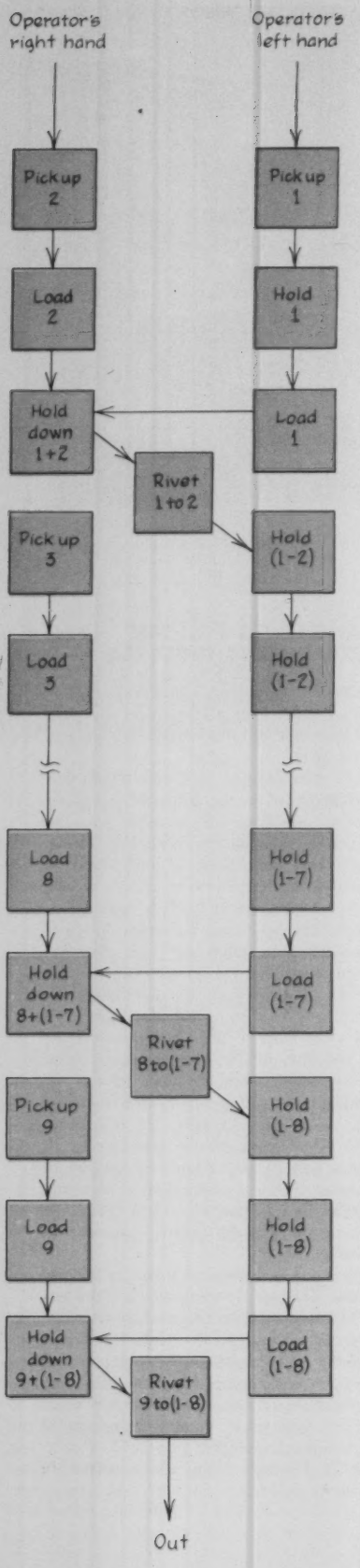
AUTO RADIOS, home radios, portable radios, phonographs, and television sets make up the bulk of the big market for receiving tubes in the entertainment industry.

Where power consumption, size, and weight are important considerations in the design of the product, the transistor has been able to move into the vacuum tube market despite the prevailing higher price. A vest pocket radio must be small, light in weight, and consume a minimum of battery power. The transistor is ideally suited for this application. However, where the appliance is meant to be a piece of furniture that plugs into an electrical outlet these attributes are not as necessary to the over-all product design, and the reliability advantage is not sufficient to overshadow the price disadvantage. This part of the vacuum tube market remains virtually untapped by transistor sales.

Leslie J. Woods, vice president—research and engineering, Philco Corp., has commented that the only way to make the consumer the real beneficiary of the development of the transistor is to produce it at a cost roughly equivalent to that of the vacuum tube. He sees automation as the only answer to achieving the process control that is so necessary to making a good quality transistor at such a cost level.

Woods indicates that, because of higher reliability, the replacement business in transistors for the entertainment industry will not be as big as is enjoyed by vacuum tubes, but he predicts a bigger transistor market on the basis of the vast potential of yet to be developed consumer products that can utilize the properties of the transistor when made available at the right price. The battery-operated portable TV is a prime example.

Automation is destined to put the transistor in the entertainment industry.



AN ENGINEERING APPROACH TO EFFICIENT

Although riveting is one of the most common assembly methods and has been widely used for many years, it has still not advanced as rapidly as other production processes in terms of efficiency. This article discusses basic considerations and describes ways to increase automation in riveting assembly.

By **JOHN H. WESSEL Jr.**, Chief Engineer, Tubular Rivet & Stud Co., Quincy, Mass.

LIKE other manufacturing operations, riveting has its advantages and its limitations. Its advantages derive from its inherent simplicity, speed, sureness, and adaptability as a fastening method. Its apparent limitations derive from the complexity, slowness, and relative inflexibility of supporting operations —planning an assembly for riveting, positioning the components to be fastened, and moving the assembly through various stages to completion. The advantages have so outweighed the difficulties that little basic thinking has been done about increasing the efficiency of the total operation.

Today, with pressure growing to cut assembly costs, some

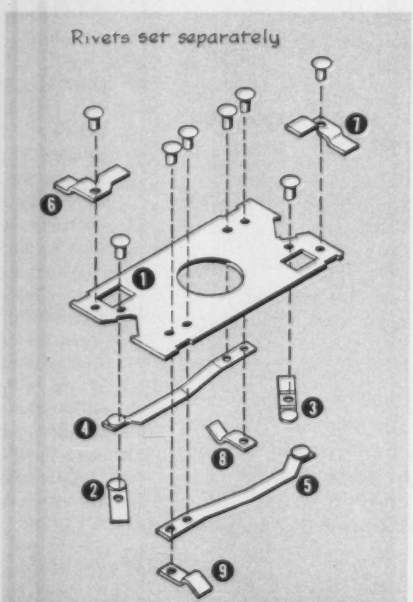


Fig. 1—Example of a "standard" manual approach to riveting problem involving nine components, represented by numbers 1 through 9, as it would be set up for a single-drive machine operated by a single operator. Included in the 56 distinct operations involved are 9 concerned with picking up a component, 23 with holding or holding down, 16 with loading a component or partial assembly, and 8 with tripping the machine to set a rivet. The exploded view is of an electrical product which might be assembled in this manner.

RIVETING ASSEMBLY

Fig. 3 — Single-stroke, multidrive riveter represents an improvement over single-drive machines where high-volume, extended production can be expected. With this type of machine, extensive modification is necessary if a design change requires a new rivet pattern.

manufacturers are tempted to regard riveting as an "old-fashioned" method of assembly, and are looking for ways to replace it as existing riveting machinery is retired to the scrap heap. This is a very short-sighted policy. It isn't sensible in view of major industrial investment in developing the riveting machine to today's level of perfection, and especially in view of the major rewards that can come through imaginative use of new techniques already developed and proved by some assemblers and manufacturers of rivets and riveting machines.

The basic advantages of rivets—particularly of semitubular rivets—hardly need to be explained here. Our primary concern is with the apparent limitations of riveting as an assembly method, and how the limitations can be overcome. They arise in two distinct areas: 1. Supporting operations that are essential to the assembly process but not part of the actual fastening operation. 2. The tendency of special riveting machines, designed for high efficiency on specific complex jobs, to become totally obsolete when the job changes. Problems in the first area can be solved by the same type of imaginative engineering that has boosted efficiency for countless other production processes. Difficulties of the second sort have already been largely removed by the development of new riveting machines which provide high operating efficiency without sacrificing adaptability to new assembly configurations.

Supporting Operations

To understand more clearly what is meant by "supporting operations" in the assembly process, consider the block diagram of *Fig.* 1. This diagram represents what might go on in a "standard" riveting assembly operation involving an operator using a single-drive machine. Nine different components, represented by numbers, are assembled together, using eight rivets set one at a time. Presented in this way, without the relief of descriptive language for the specific components, the whole operation appears to be impractical. The basic repetitiousness and wastefulness are plainly exposed. Note, for example, how many operations are indicated only as *Hold* or *Hold Down*. In a total of 56 distinct operations involved, 86 per cent are supporting op-

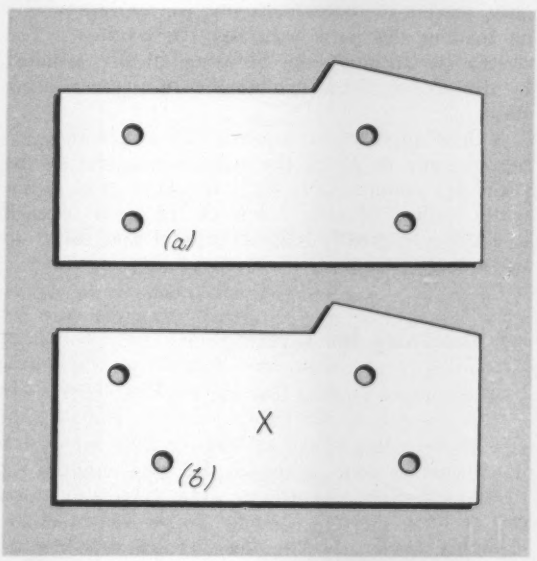


Fig. 2—Design of rivet pattern is of considerable importance in obtaining an efficient and economical riveting operation. Four separate operations would be required to set rivets in the asymmetrical pattern of part (a). The symmetry of part (b) permits rivets to be set in only two operations by rotating the part about its center point, or by sliding the part left or right, beneath the head of a double-drive machine.

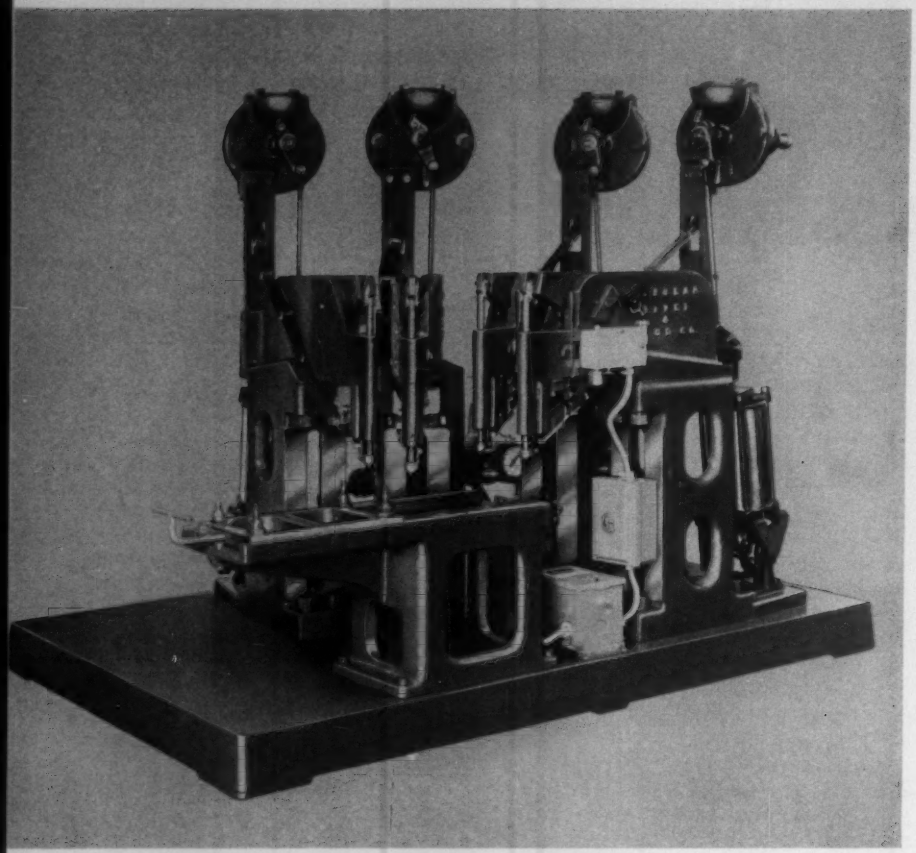


Fig. 4—Typical multihead riveter developed by Tubular Rivet & Stud Co. consists of a base plate supporting a group of independent single-drive machines and necessary work-holding and fixturing means. The building block concept permits adaptation of the equipment to new designs of rivet patterns. The base plate would be supported at a desired height on a suitable table or framework (not shown).

erations—picking up, holding, holding down, and loading or positioning; only 14 per cent are actual riveting.

Though many instances exist where supporting operations are somewhat more streamlined, such instances are the exception rather than the rule. Obviously, any attempt to make the assembly process more efficient will be most productive if it starts by eliminating as many independent supporting operations as possible, and reducing the unproductive time of the operator and the machine.

One approach which has been widely used, even with single-drive riveting machines, is to design a loading fixture on which all or nearly all of the components are positioned in the correct pattern for riveting. Loading is still done by hand, but both hands are productively occupied, and the operator time is shortened considerably. The loading fixture is designed to accommodate the components of the assembly, and contains an anvil at each point that will require a rivet. Locating devices, such as milled slots, pins, and support brackets, can be added to aid loading and insure proper location of parts. A clamping device is frequently used to hold down the unriveted components so that spring-loaded anvil pins which guide the rivets through their work holes will not raise the work, spilling the components off the fixture each time a rivet is set.

A second approach to improved efficiency is to mechanize the transfer of the work through one or more loading stations to the final riveting position. This is frequently done by means of dial-type indexing tables, which rotate from position to position at a fixed rate, and which may permit two or more operators to be used at various stations. The transfer operation is thus taken out of the manual category, leaving the operator free to concentrate wholly on loading the parts accurately in position. The riveter (or riveters) can be automatically actuated by the arrival of the loading fixture at the riveting station.

A third approach is to provide for automatic feeding of some or all of the components, just as the rivets are automatically fed. In many cases, automatic feeding of only a few of the parts of each assembly can greatly reduce the total time taken up by loading operations.

▶ Designing for Riveting

With proper loading fixtures, mechanized transfer of the assembly to the riveting station, and perhaps automatic feeding of at least some of the components, much can be done to reduce the time required for these supporting operations. However, still more can be done through foresight in the design of the assembly itself. Often, the specific locations of

rivets in an assembly are not too critical. Any one of several fastening patterns can produce basically the same result, as far as the functioning of the assembly is concerned. Where such a choice might exist, it is wise to consider the alternatives in terms of efficiency in the assembly process.

Fig. 2 shows two ways in which an assembly might be designed to be held together with four rivets. In both, two rivets are located near each end of what may be a base plate of some sort. The rivet patterns differ only slightly, but in an important way. In (*a*), the pattern made by the four rivet positions is unsymmetrical. No sliding, rotation or flopping of the assembly can make any two of the holes fall over the same spots previously covered by the other two. In (*b*), the pattern is symmetrical. If the unit is fixtured to slide, or to rotate 180 degrees around a pivot at the center point of the assembly, the holes at each end can be placed exactly under the same riveting positions.

The latter design permits the use of a double-head or double-drive riveting machine, operating on centers which are correct for the two riveting positions at each end of the unit, and the use of either a sliding fixture or a loading fixture which is pivoted at the center and can be rotated at the riveting station. As compared with the unsymmetrical design, which would require four separate riveting operations, the symmetrical design requires only two riveting operations. Actual per-unit production time would be cut considerably because the time needed to lift the unit off a single anvil and reposition it four times is reduced to the time needed for a simple sliding motion or rotation.

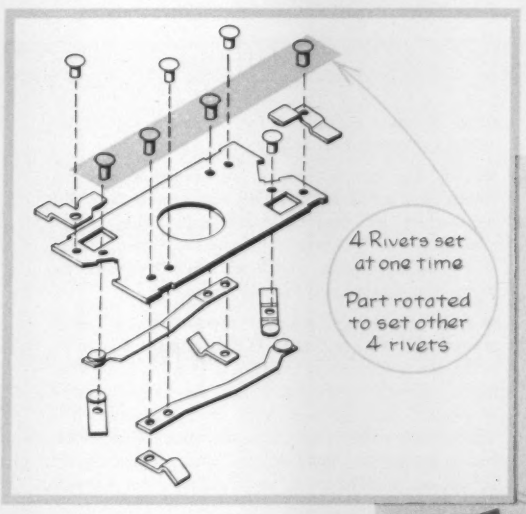
Proper assembly design, with riveting in mind, pays off again in permitting still further mechanization of transfer operations. When several rivets can be set in a single operation of the machine, the machine itself can often be actuated by the arrival of the assembly at the riveting position. Since the operator at the riveting station performs fewer acts, the entire cycle of loading, transfer, and riveting can move at a pace that is set only by the complexity of the assembly and the skill of the operators.

As a final step in streamlining the supporting operations, automatic sensing and ejection can be engineered into any station of the riveting cycle. The major area remaining then, for increased efficiency, is in the design of the riveting machines to perform more complex tasks faster, while still being adaptable to new assembly designs.

▶ Multiple-Riveting Machines

Because a riveting machine that sets more than one rivet at a time gets the job done faster, many assemblers have turned to fixed-center, single-stroke, multiple-drive riveters, *Fig.* 3. With such machines, two to four rivets are set by a single stroke, according to the number of drivers fitted to the spindle. Fed by separate hoppers, each driver can if necessary set rivets of different dimensions.

Multiple-drive riveters are inherently limited to



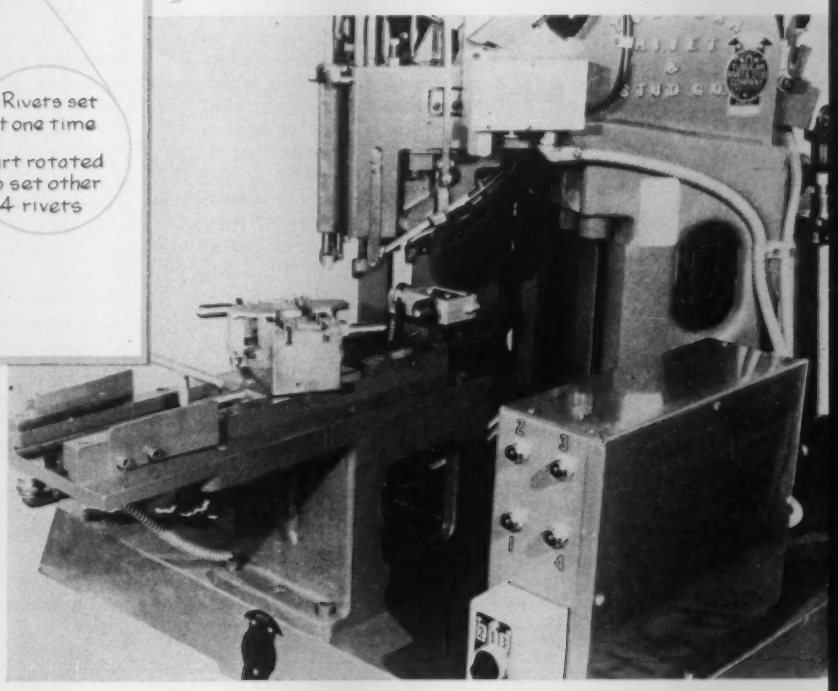


Fig. 5—Multihead riveter designed to assemble parts shown in exploded diagram represents a considerable improvement over process diagrammed in *Fig.* 1. With this machine, only 24 operations are involved, consisting mainly of picking up and placing components on fixture. Pushbutton panel permits operator to preselect which individual riveters are to operate when fixture is positioned.

riveting patterns in which all the rivets lie in a restricted area. Furthermore, while they are economical and efficient for high-volume production of an established assembly pattern, each machine is "frozen" to the single riveting pattern for which it was designed. If an assembly design changes, either the riveting pattern must be kept unchanged, or the existing riveter must be modified—usually at high cost. Often, a completely new multiple-drive riveter must be bought for the new job.

To overcome these drawbacks, without sacrificing the advantages of multiple riveting, double-drive machines are available in which center distances are adjustable over a wide range by means of a hand operated traverse screw. For setting more than two rivets at once, a new type of riveting machine has recently been developed and successfully applied to a great variety of assembly problems. This is the multihead riveter, *Fig.* 4.

In the true multihead riveter, the rivets are fed and set by independent single-drive machines of a compact design, grouped on a common base plate to match the rivet pattern of the assembly. Each machine has a power source (usually an air cylinder), a hopper, and the ability to feed rivets. The machine can easily be changed to accommodate rivets of different styles and dimensions. Because each machine has its own power source, positioning is completely flexible, and there are virtually no restrictions on the rivet pattern—even the thickness of the assembly can vary from one rivet position to another.

With such a machine, many aspects of the supporting operations can be planned for high efficiency —loading fixtures which position and hold all of the assembly components; transport mechanisms which permit two, three, or more operators to be productively employed; accessories which permit additional operations, such as lubrication, to go on during the actual assembly process; and sensing devices to trip the riveter and eject the finished product.

Furthermore, a radical design change to a totally new rivet pattern does not mean that a major machinery investment must be written off. Instead, some or all of the existing single-drive riveters, and additional ones if necessary, are simply regrouped on a base plate to match the rivet pattern of the new assembly. Quite often, the old base plate itself can be redrilled to mount the separate riveters in the new locations.

With this development, the obsolescence problem of multiple riveters has been effectively answered. Paralleling the development of the machines themselves, graphic design methods have been devised which permit the machine builder and the production engineer to work together in rapidly and accurately planning the multihead riveter required for any assembly job, directly from blueprints of the assembly. This practical approach to assembly planning is possible only because of the inherent

TABLE 1—Riveting Considerations

- If some of the fasteners currently used in an assembly are not rivets, could semitubular rivets be substituted? Bear in mind that riveting is fast, economical, and more versatile than you might realize. Wherever a rivet can replace hand-driven fasteners, savings may be substantial. An interesting recent development is Tubular Rivet & Stud Co.'s Perma-Nut. This special tubular rivet is automatically fed and set just like an ordinary semitubular rivet, but is internally threaded to serve as a nut or nut plate.

- Is the assembly suitable for multihead riveting? If three or more rivets are used, the chances are excellent that this new type of machine would be a highly profitable investment—not only because of its low obsolescence, but also because it increases the possibilities of automation of supporting operations.

- Is the assembly itself properly designed for riveting? Check for possible symmetries in the rivet pattern to simplify transfer motions; possible clearances to permit riveting, without altering basic design; and possible needless variations in assembly thickness. Remember, though, that independent air-powered riveters can accommodate wide thickness variations even in brittle materials, without causing breakage.

- Can any components of the assembly, besides rivets, be automatically fed—or could they be redesigned for automatic feeding? Every automatically-fed component eliminates two hand movements: Pick up, and load. Also, it greatly reduces the chances of human error.

- Can any of the transfer operations be mechanized—or even automated? Study the possibilities of using a dial table, or an in-line type of conveyor. Consider the values of the simpler kinds of sensing devices, to trigger or to interrupt various actions without operator attention. With sensible planning, the cost of this kind of automation is modest, and is easily recovered by consequent savings.

- With transfer operations mechanized, could additional operators work productively on the assembly job? It is perfectly possible to plan an assembly operation so that one, two, three, or even more operators can be effectively used depending on production requirements. The mechanized transfer rate is simply set slower or faster accordingly. A system of this sort makes optimum use of skilled labor, regardless of varying production demands on the industry.

THE AUTHOR

JOHN H. WESSEL, Jr., chief engineer, joined Tubular Rivet & Stud Co. after 4 years active service in the Naval Air Force during World War II. A full background of experience in every type of riveting operation has been gained during the 9 years in which he has been associated with the engineering department. For the past 2 years, Wessel has headed up the engineering department, where he is responsible for the direction of both production and development engineering. He attended Lincoln Technical Institute, a division of Northeastern University, where he received an engineering degree and a B.B.A. degree.

As part of an engineering-management team, he shares in responsibility for developments which have updated riveting—integrating a time-honored assembly method with more modern production techniques in what Tubular Rivet and Stud Co. refers to as Production Automated Riveting (PAR).

simplicity and flexibility of the multihead riveter development, and drastically reduces the engineering costs that would normally be expected in custom-designing a major production machine.

▶ A Specific Example

To appreciate the results of imaginative planning, with machines of this new type, consider the assembly shown in *Fig.* 5. This assembly is in fact the one about which the block diagram of *Fig.* 1 was constructed in terms of single-head riveting. An electric motor starter switch assembly, it consists of a base plate, two contact leaf springs, four contact brackets, and two support brackets. The parts are fastened together with eight rivets. In actual production, three different models were made on a mixed production schedule: One model included all components as shown, a second model eliminated one of the contact brackets, and a third eliminated two contact brackets.

Note that the pattern of rivet positions shows the kind of symmetry previously mentioned as highly desirable. A 180 degree rotation about a pivot in the center of the assembly will cause the four rivet holes at one end of the base plate to swap positions exactly with the four at the other end.

The TRS Multi-Head Riveter designed for this job uses four automatic riveters and a loading fixture which accepts all of the components and which can be rotated 180 degrees. The single operator picks up and loads the nine components in the correct sequence, positioning them on the specially-designed loading fixture; slides the fixture forward to the riveting position where a relay automatically trips the machine to set four rivets; partially withdraws the fixture to rotate it to the second position; slides it forward again for the second four rivets to be set; withdraws the fixture; and unloads the finished assembly.

The complete assembly process consists of 24 distinct operations, instead of 56 as before. There are only 22 supporting operations as compared with the previous 48, and none of them is a mere *Hold* or *Hold Down*. The operator's hands are productively occupied at every step. Furthermore, machine time is reduced to just two operations instead of eight—a substantial increase in actual riveting efficiency.

To handle the other models of the assembly that require either one or two fewer rivets, a simple push-button panel was installed on the front of the machine, permitting the operator to cut out of the trip circuit those riveters not used, *Fig.* 5. Finally, if at some future date the basic design of the starter assembly is changed so that the existing rivet pattern cannot be used, the independent automatic riveters can be placed in new positions on a new base plate, saving most of the cost of a new multihead riveter for the new assembly job.

▶ Check Points

In the fabrication industries, no part of the production process is more variable than the assembly job. The development of new or improved products constantly changes product designs, and therefore assembly requirements. For this basic reason, no hard and fast blueprint of efficient assembly methods is possible, and assembly engineering remains one of the most demanding—and rewarding—fields for creative work.

Still, a few general guides can be set down to help assembly engineers assess their present methods for possible cost-cutting improvement, TABLE 1. Stated as questions, these guides are worth consideration. The specific answers will depend on particular circumstances, but the successful effort to find the answers has already been amply repaid in the experience of many manufacturers.

All of the questions have a common but not too obvious implication: Planning for increased riveting efficiency is not quite a "do it yourself" proposition. Modern riveting machines are capable of doing wonders on the production line, but their effective application requires the combined efforts of the assembly engineer and the riveting specialist both before and during production. This is particularly true of multihead riveters. Continually working together, the assembly enginer and the riveting specialist can quickly find the best solutions to assembly problems, where rivets are applicable. The results are seen not only in terms of lowered assembly costs, but often in improved product characteristics as well.

MAGNETIC DISC MEMORY DELAYS CONTROL ACTIONS

PROVIDING automatically operating equipment with a modicum of memory can be important to obtaining maximum production rates. For example, consider a production process involving several sequential operations punctuated by automatic inspection devices. The inspection equipment might signal that one operation was not properly performed. Need the entire line always be stopped for corrective action? The defect could have resulted from some random cause, in which case a better course of action would be to continue to pass the defective part through the production line—accepting the reject without penalizing production time.

This is the type of case in which the ability of a machine to "remember" is important. It must be able to distinguish the defective part during its travel through the production line. Additional operations should not be performed on the defective part, and it should be rejected at a time and location convenient to the operation of the entire line.

Automation Inc. has developed a dual channel memory unit for independent control of two separate operations by delayed signals based on measurements made upon affected parts or material at two or more earlier stations on a production line. The unit is particularly applicable to production operations involving individual parts, such as metal cans, paper cups, drill blanks, ball bearings, filling operations, etc., which might be inspected for two categories of defects.

The memory element is a magnetic steel disc mechanically coupled to the process line. This coupling relates angular rotation of magnetic signals on the disc to the location of designated parts or material along a production line. Magnetic storage and sensing in the memory is not affected when starting, stopping, jogging, speeding up, or slowing down the process line.

An application of the memory unit to the filling and capping of bottles is shown in *Fig.* 1. The memory control initiates three actions: It insures that liquid is not released if a bottle is missing; it causes partially filled bottles to be rejected before they are capped; and it prevents a capping action if a bottle is missing.

As shown in the illustration, bottles enter the machine from the left on a conveyor. If a bottle is missing, a photoelectric inspection device causes a signal to be written on the outside track of the dual track memory disc. When that part of the filling table corresponding to the missing bottle reaches the filling station, the signal on the memory disc passes beneath a read head and initiates a control action preventing the operation of the filling mechanism.

Continuing down the production line, bottles are inspected by a second photoelectric inspection device to determine if they are filled. If they are not filled, a signal is recorded on the inside track of the memory device. Subsequently the bottle is rejected as the signal causes a reject mechanism to operate at a later point in the production process.

A third read head on the memory device is sensitive to a signal contained on either of the recording channels. This read head is connected in the capping mechanism control circuit and prevents the capper from operating except when a filled bottle is present to be capped. An erase head is located between the last read head and the first write head to erase all magnetic signals from the rotating memory disc—signifying that part of the continuously moving flow of production has passed the point of concern so far as the filling and capping operations are involved.

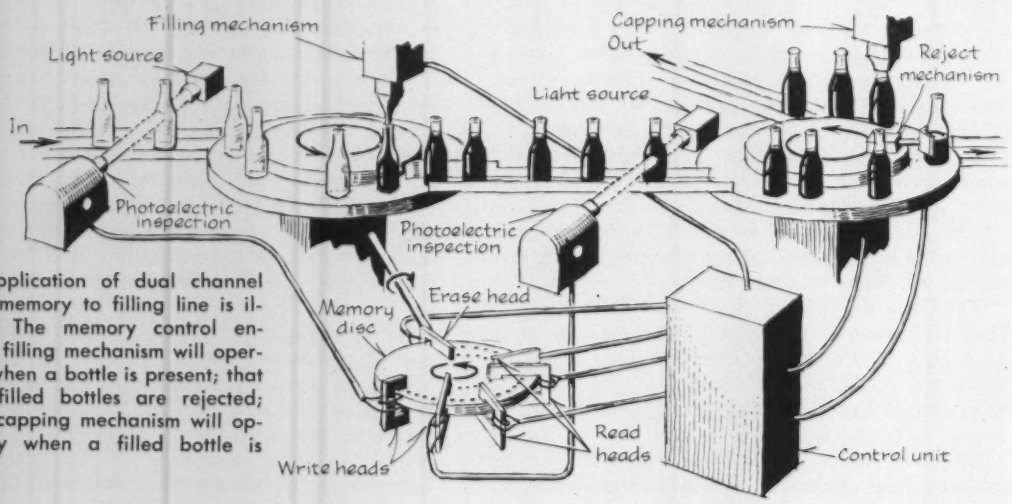
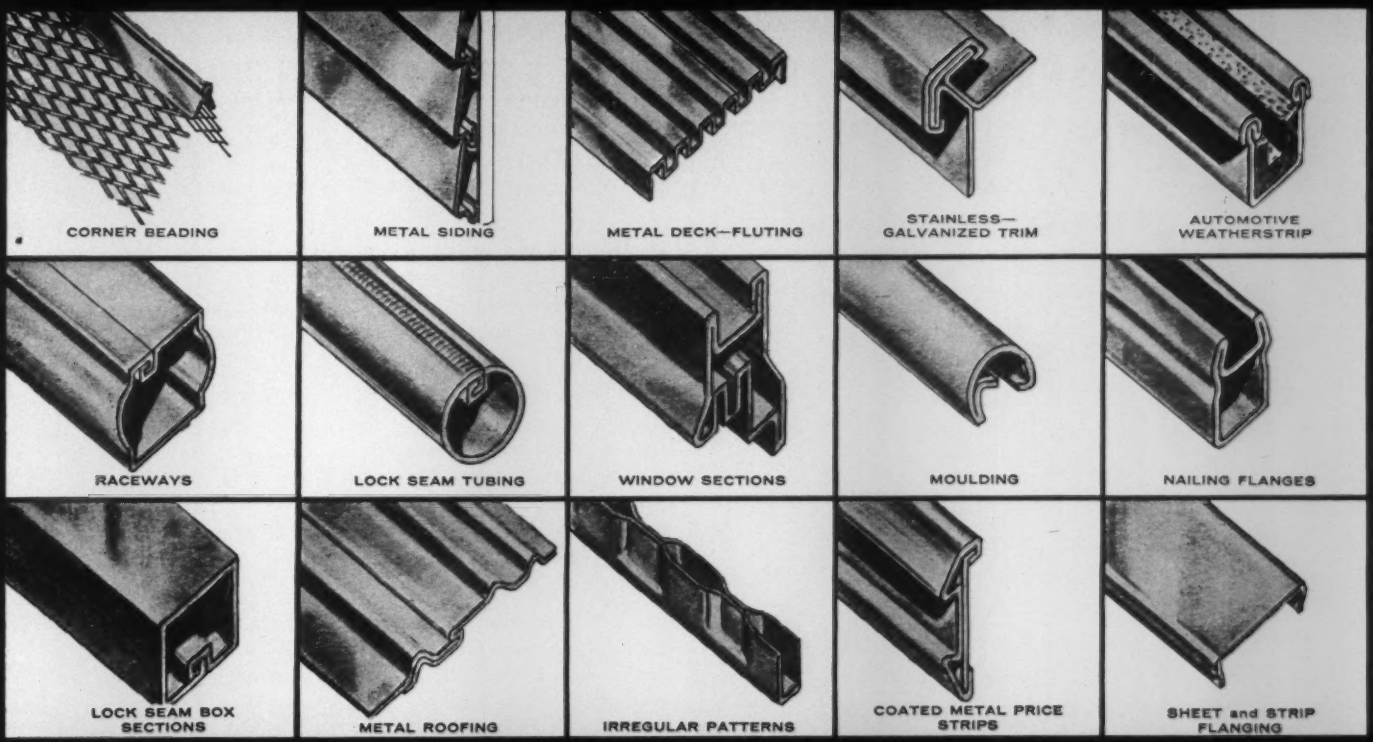


Fig. 1—Application of dual channel magnetic memory to filling line is illustrated. The memory control ensures that filling mechanism will operate only when a bottle is present; that partially filled bottles are rejected; and that capping mechanism will operate only when a filled bottle is present.

The Shapes of Things to Come



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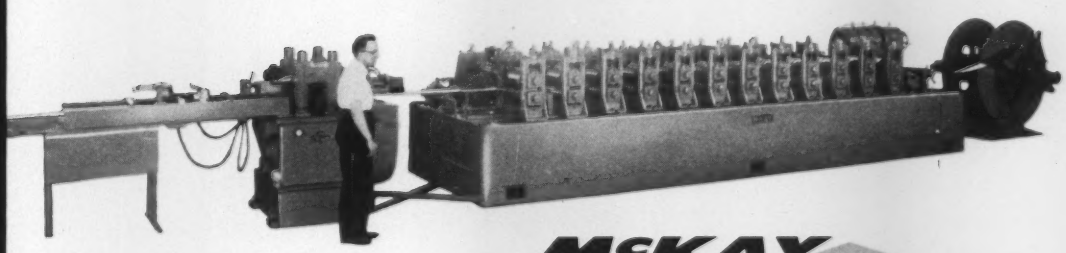
Be sure you have checked with McKay before you order forming equipment. You'll find this unmatched precision and ruggedness pays off in better forming at greatly reduced costs. And with a McKay—you're ready for tomorrow!

The McKay Machine Company, Youngstown, Ohio



McKay Forming Machines are quality throughout. They're designed and built to deliver year after year with minimum maintenance. Note sturdy construction of machine pictured above.

McKAY MCK MACHINE

Circle 674 on Page 17

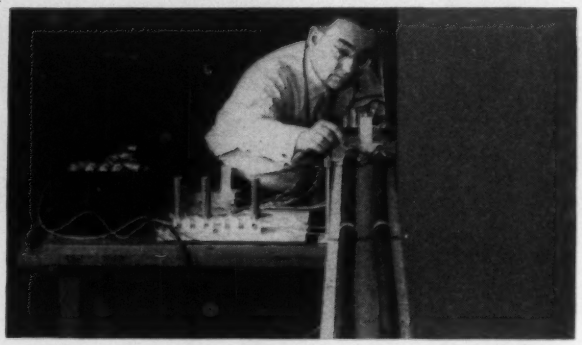
THEY PROBE THE FUTURE OF DEEP-SEA TELEPHONY

"Dry Land Ocean," under construction at Bell Laboratories, simulates ocean floor conditions, is used to test changes in cable loss. Sample cables are housed in pipes which contain salt water under deep-sea pressure. The completed trough is roofed in and is filled with water which maintains the pipes at 37° F., the temperature of the ocean floor.

Deep in the ocean, a submarine telephone cable system is extremely hard to get at for adjustment or repair. This makes it vitally important to find out what can happen to such a system *before* it is installed.

Bell Laboratories engineers do this by means of tests which simulate ocean floor conditions on dry land. Among many factors they test for are the effects of immense pressures on amplifier housings and their water-resistant seals. They also test for agents which work very slowly, yet can cause serious destruction over the years—chemical action, marine borers and several species of bacteria which strangely thrive under great pressures.

Through this and other work, Bell Telephone Laboratories engineers are learning how to create better deep-sea telephone systems to connect America to the rest of the world.



Highly precise instruments developed by Bell Laboratories engineers are used to detect infinitesimal changes in cable loss—to an accuracy of ten millionths of a decibel.

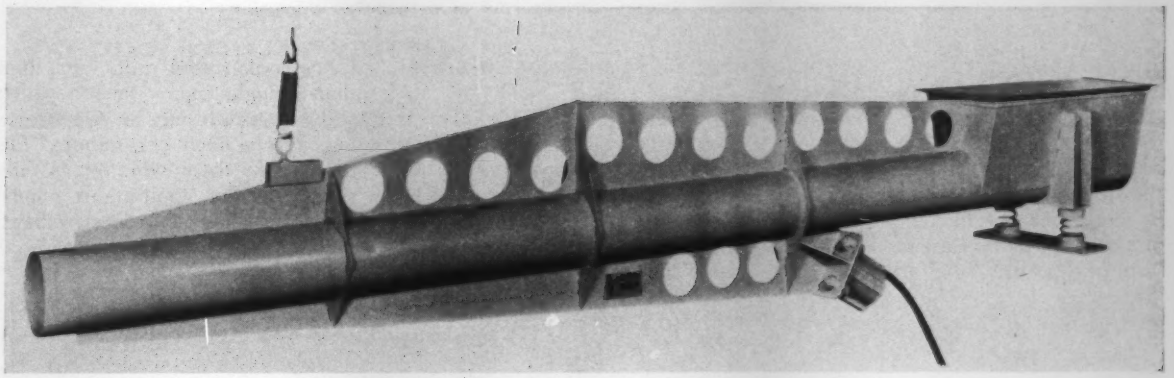
Seawater and sediment in bottle characterize ocean floor. Test sample of insulation on coiled wire is checked for bacterial attack by conductance and capacitance tests.

BELL TELEPHONE LABORATORIES
WORLD CENTER OF COMMUNICATIONS
RESEARCH AND DEVELOPMENT

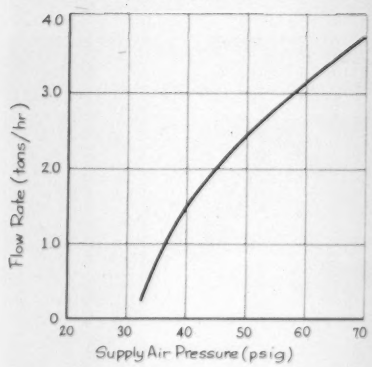
AUTOMATION

new equipment

Machines and plant equipment for more automatic operations.
For detailed information and literature, use card page 17.



Tubular unit of steel is 10 feet long, 6 inches in diameter, can move 1 ton per hour of foundry sand.

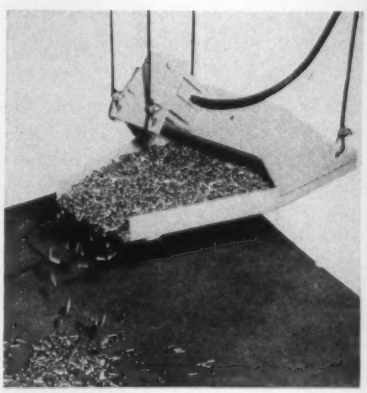


Graph illustrates virtual straight-line relationship between material flow rate and supply air pressure for vibratory equipment.

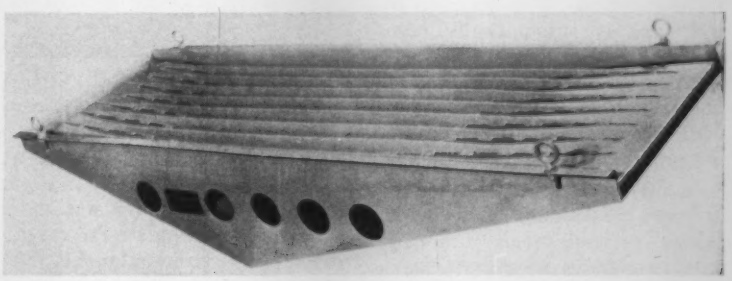
Tube & Pan Pneumatic Conveyors

ORDINARILY hard - to - handle materials can be accommodated with line of pneumatic feeders and conveyors available in either tubular or open pan types (see illustrations). The units can provide controlled flow of materials from bins, hoppers, and chutes; they can steadily feed parts to machining and assembly operations; and settle granular materials and semithick liquids in containers or molds. The units, manufactured by **Cleveland Vibrator Co.**, 2828 Clinton Ave., Cleveland 13, Ohio, are constructed without springs and feature a vibratory drive which provides the oscillating motion to convey bulk material in a tray or through a tube.

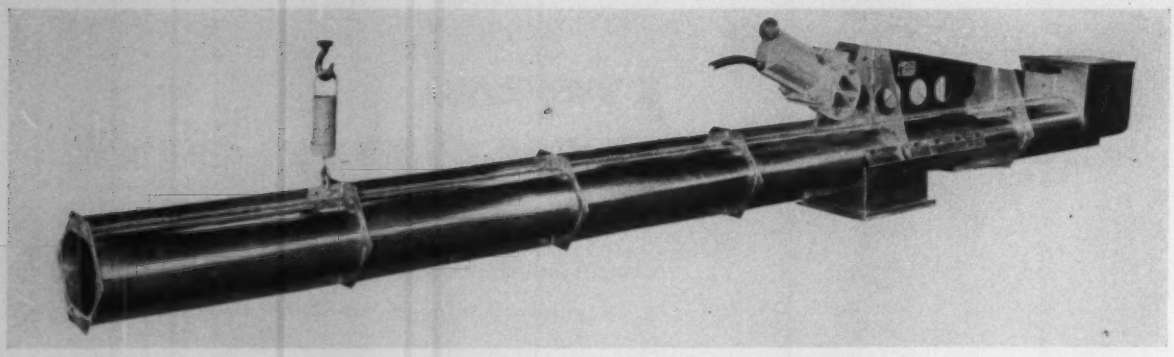
The vibratory drive consists of a piston moving inside a casing. The casing is ported to provide auto-



Pan unit is 24 inches wide, 30 inches long. It moves steel rivets at a controlled rate of 0.4 fps. In use, pan is immersed in a salt water quench.



Aluminum unit is 60 inches long, 18 inches wide. It can move steel stampings effectively between successive operations.



Tubular aluminum unit is suitable for the food industry, is 18 inches in diameter, 15 feet long. It can move 1 ton per hour of dehydrated apples.

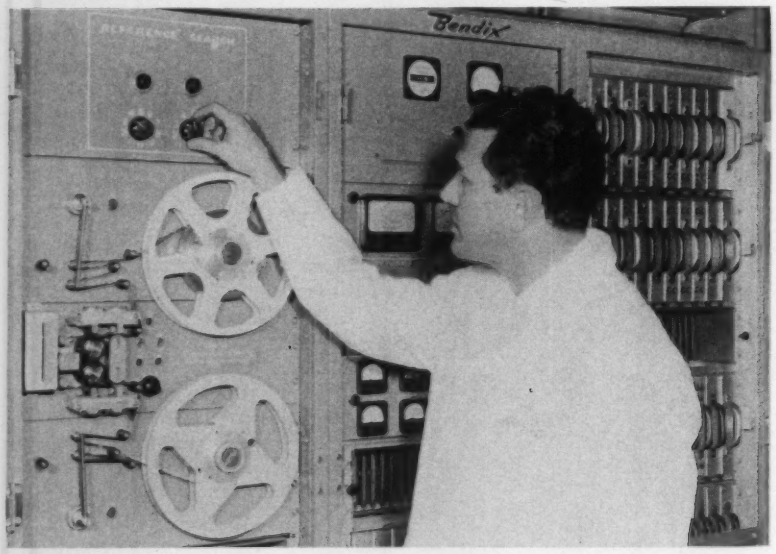
matic reversal of piston movement without impact against the ends of the casing. The vibrator piston is the only moving part in a conveyor or feeder. By attaching a hose to the vibrator exhaust, exhaust air can be discharged at a remote point and all moving parts can be isolated from the surrounding atmosphere. Units will operate when immersed in fluids.

The quantity of material flow is varied by changing the operating air pressure as shown in the accompanying chart. This is done by the use of a pressure regulator. Velocity of flow, depending on unit size, is between zero and 60 fpm. Using a pan type unit, tests show that a single layer of teflon pellets will move uniformly at velocities as low as one inch per minute. The noise from these vibrators is only slight, but for applications requiring a very low noise level, exhaust mufflers can be supplied.

Circle 401 on Page 17

Numerical Machine Control System

Item 402



Numerical control system can automatically select from as many as 100 specific part programs or part reference points. It is also suitable for control of up to 80 auxiliary *On-Off* functions. Equipment features a tape search device. Up to 100 part programs are stored on one reel of tape. Each part program or reference point is given a number. By setting two rotary switches, the operator selects the desired part program to be followed. The machine control tape is automatically repositioned to the beginning of the selected program. When the tape has been repositioned, an optional two-digit decimal display can indicate the program or part to be machined.

In the event of interruptions such as lunch breaks, shift changes, power failure, or tool breakage during a long machining operation, the use of reference points assists the operator to readily regain synchronization between the machine tool and the control tape. The tape is automatically backed up to a reference point by the pushing of a *Return To Reference* button. The reference point it reaches can be indicated by the decimal display and the operator can manipulate the machine to the proper position for that reference point as shown on his worksheet.

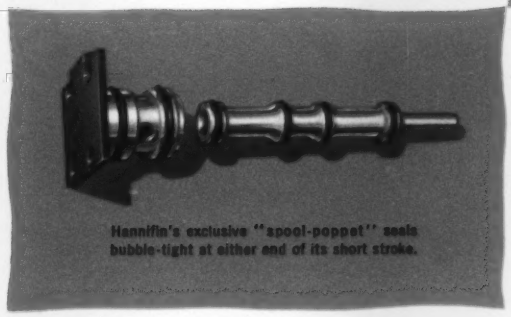
The tape reader can also read and control up to 80 *On-Off* auxiliary control functions which are punched in a special code on the machine control tape. The functions which can be controlled include: Coolant flow, chip conveyor, spindle power, speed selection, return tape to starting position, clamping, table indexing, and tool changes. **Industrial Controls Section, Bendix Aviation Corp.**, 21820 Wyoming Ave., Detroit 37, Mich.

Circle 402 on Page 17

Circle 675 on Page 17→

From HANNIFIN... unit construction to give you air valves that do more jobs

Hannifin ¾" four-way valve with "universal" base and new Speed Control section. Single-solenoid actuated, 10 other actuators available.



Hannifin's exclusive "spool-poppet" seals bubble-tight at either end of its short stroke.

For complete J.I.C. compliance, valve is electrically inoperative until dust-tight, splashproof solenoid cover is replaced and fastened tightly. Result: no more clogged, jammed solenoids.

One of the versatile—and most popular—Hannifin air control valves is this "CC" series, single-solenoid model. It is available for either ¼" or ⅜" air lines and is gasket-mounted to its own base. This particular base (one of three choices offered) can either be O-ring gasketed to your manifold or mounted over an opening in your bracket or machine. It will receive all four lines from below or take the inlet line from below and the two cylinder lines out one side. Or, you can make all connections at the sides.

When it comes to actuation, Hannifin offers an even wider selection: hand, foot, cam, pressure, single or double solenoid.

When necessary, you can remove this entire valve from its base without disconnecting air lines. Or, the exclusive "spool-poppet" can be replaced without even breaking electrical connections.

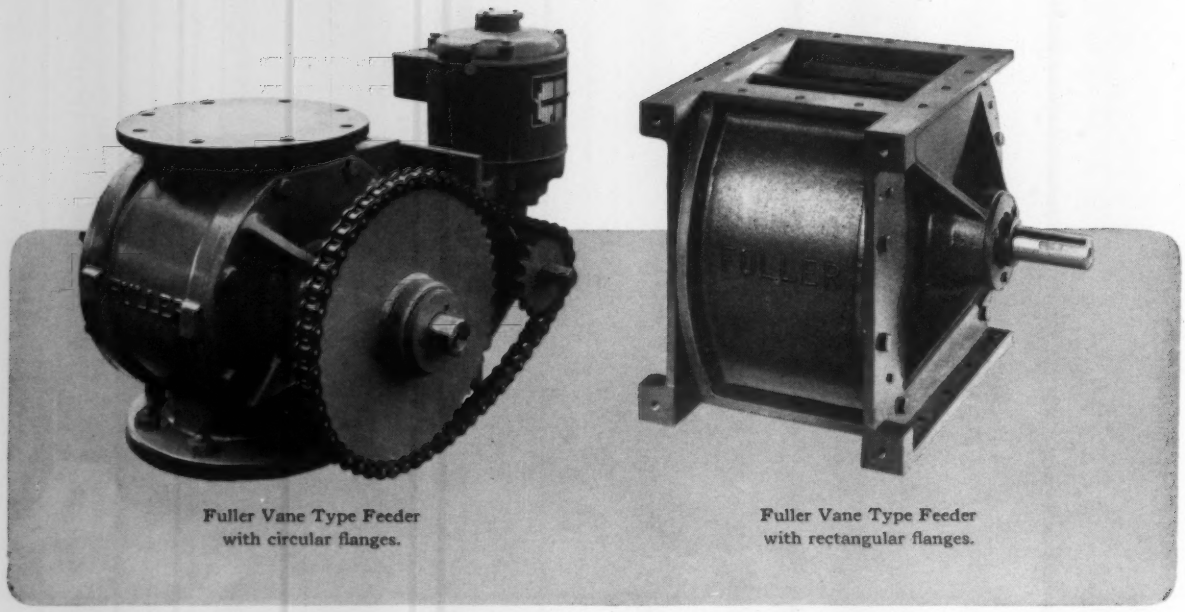
The "CC" series, like all Hannifin valves, is designed with "full flow" internal passages as large or larger than its rated pipe size.

You will find these and most other Hannifin valves described in Hannifin's new "Valve Finder." Get your copy from your Hannifin man, listed in the A-Z volume of Thomas' Register, or write:

HANNIFIN COMPANY
525 South Wolf Road • Des Plaines, Illinois

Fuller Feeders Keep Conveyors Flowing Freely

. . . whether the load is a few pounds a minute or many tons an hour



Fuller Vane Type Feeder with circular flanges.

Fuller Vane Type Feeder with rectangular flanges.

Fuller Vane Type Feeders assure you of dependable handling of dry, pulverized and granular materials. They're available in capacity ranges to meet all normal plant requirements, and are built with circular or rectangular outlets. Check these Fuller cost-saving features . . .

Extra-rugged construction. Heavy, cast iron body walls and headplates add rigidity, longer life. Stainless or other metals can be used where sanitary or corrosion requirements demand their use.

Sealed bearings are equipped with Alemite fittings for ease of lubrication and long life. Abrasive particles can't enter, maintenance is cut.

Make effective air locks. Fuller Vane Type Feeders can be used as air locks for pressure differentials up to 3½ lbs.

Stuffing boxes and ball bearings for vacuum, low-pressure and general applications.

And, where extreme volumetric accuracy without pulsation is needed, there's a line of Fuller Roll Type Feeders. For full details on Fuller Feeders write for Bulletin.

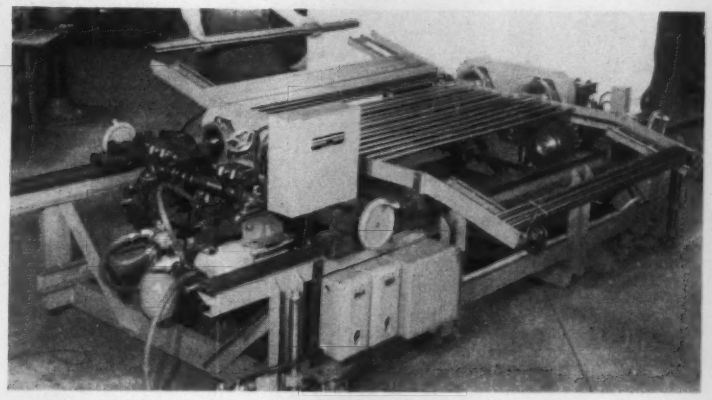
1306
F-20

FULLER COMPANY GENERAL AMERICAN TRADE MARK

Fuller
. . . . pioneers in harnessing AIR

FULLER COMPANY
162 Bridge St., Catasauqua, Pa.
SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION
Birmingham • Chicago • Kansas City • Los Angeles • New York • San Francisco • Seattle

Circle 676 on Page 17



Tubing End Roller

Item 403

Equipment simultaneously operates on both ends of thin-walled tubing to remove dents, burrs, and sharp edges caused by the shear cut. It can also remove the restriction caused by a disc-type rotary cut-off tool, restoring the original tube shape within close tolerances. Deformed tubes will not damage the machine. Production rate is up to 70 tubes per minute. Machine can be operated directly from the fall-out table of a tube mill. It is available in models for tubes ranging from 12 inches to 20 feet in length and from $\frac{1}{2}$-inch to 3 inches in OD and up to $\frac{1}{8}$-inch wall thickness. **Automation Design & Machinery Co.**, 532 E. 178th St., New York 57, N. Y.

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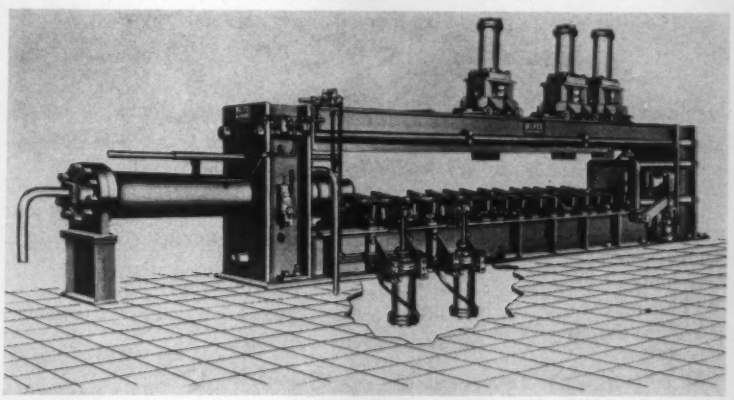


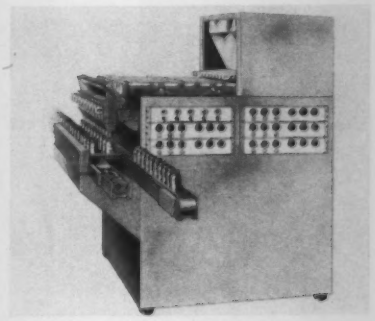
Hydraulic Billet Centering Press

Item 404

Horizontal type, hydraulic press is designed to produce center punch marks in the ends of billets prior to piercing them into steel tubing. It is located between the furnace and piercing mill. The horizontal punching and clamping cylinders are hydraulically operated. In use, after the billet comes from the furnace, it is placed on a conveyor and rolled into the work area of the press, where it is stopped by kick-out arms in the *Up* position.

The kickout arms then operate to lower the billet into a V-way in a ramp. Vertical clamps lower and clamp the billet in the V-way; at the same time a pusher ram advances and clamps the billet against a face plate. The centering ram is then advanced and retracted. All holding clamps also retract, and an ejector moves the billet back from the face plate. The kickout arms place the billet on a ramp, which rolls it to the piercing mill. The press is then ready to repeat the cycle. The complete cycle of operation takes 3 seconds. The press in the illustration shown can handle billets in sizes ranging from $4\frac{1}{2}$ to 12 inches in diameter, and from 3 to 15 feet in length. Centers can be varied from one inch to $1\frac{3}{4}$ inches in diameter, to a maximum depth of 6 inches. The punch holder mounted on the centering ram can be adjusted vertically to accommodate different diameters, and a limit switch adjusts the pusher ram stroke, so that billets of different lengths can be handled. **E. W. Bliss Co.**, 1375 Raff Rd., Canton 10, Ohio.

Circle 404 on Page 17



Counting Machine

Item 405

Designed especially for the pharmaceutical field, electronic counter is capable of counting up to 12,000 bottles of 100 tablets or capsules per hour. The machine can handle a range of regular or irregular shaped compressed and coated tablets or capsules. Machine is available with from 2 to 10 orientation channels (illustration shows a 10-channel machine). Each channel is equipped with its own feeder, flow divider, detector, and electronic controls.

In operation, the capsules are fed from a supply hopper to a high speed belt, which is traversed with orientation guides. From there they pass through the photodiode detector and flow divider and are funneled individually into bottles. As each bottle receives the required quantity, the flow for that bottle is automatically interrupted by the flow divider. When all the bottles are full, the machine positions a new group of bottles underneath the filling spouts and the cycle is repeated. **Delta Engineering Corp.**, 126 W. Emerson St., Melrose 76, Mass.

Circle 405 on Page 17

PRODUCTION AUTOMATED RIVETING *a major break-through in the Automation of Assembly*

PAR ... **Originated by TRS** with the invaluable collaboration of some of industry's top production engineers who sought a major break-through in the automation of assembly operations to reduce costs.

PAR ... **A name given by TRS to its Production Automated Riveting process** . . . continuously developed and perfected for 3 years. Proved successful in some of industry's most efficient plants. Now, TRS has sufficient engineers especially trained in the PAR process to serve all manufacturers.

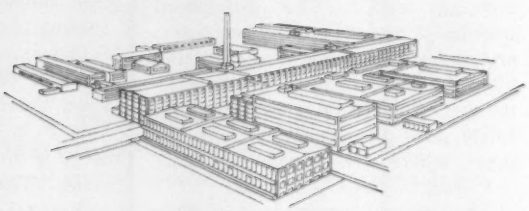
PAR ... **It makes riveting practically a new fastening method through efficiently integrated and automatic . . .**

1. FEEDING of tubular rivets or related products.
2. TRANSFER of parts between riveter stations by means of sliding or rotating fixtures or dial tables. Or through synchronization with conveyors.
3. SEQUENCING the operation of from 3 to 15 rivet setters which make all fastenings simultaneously or in any desired sequence.
4. CONTROL of setting force as required by parts thickness or material characteristics.
5. SENSING of improper conditions and stopping equipment to avoid injury to parts, equipment or operator.
6. EJECTION of parts as required.

TRS®

TUBULAR RIVET & STUD COMPANY

QUINCY 70, MASS.



Midwest Office & Warehouse in Chicago • SALES OFFICES: Atlanta • Buffalo • Charlotte • Chicago • Cleveland Dallas • Detroit • Hartford • Indianapolis • Los Angeles New York • Philadelphia • Pittsfield • Quincy • St. Louis Seattle. *See "Yellow Pages" for phone numbers.*

FORD

almost tripled production —without adding to payroll

Ford engineers wanted to step-up the production rate on a window gear and cam assembly. They called in TRS engineers.

Here is the remarkable automatic TRS Machine that resulted. Because center distances would not permit employment of a Multi-Head Riveter, a triple drive machine was adapted by TRS engineers. This eight dial station set-up receives a gear and cam assembly . . . greases it . . . receives a shaft and housing . . . sets three rivets to fasten shaft and housing to the gear and cam unit . . . ejects complete assembly. The machine does everything but load the parts. Ford Motor Company know-how shows in the profitable solution . . . so does TRS ingenuity and experience.

You get the benefit of TRS "recognized ability" when you buy any TRS Riveting Machine . . . from the simplest, standard type to a complicated special design.

TRS offers more machines, to more exactly meet your need . . . will lease but likes to sell . . . guarantees performance and sticks by you with all-out service.

PAR . . . It's a TRS Process for very good reasons!

Obviously, there are two critical elements in the PAR Process. Essential is the special and extensive knowledge and experience needed to design an integrated system of standard or multi-head riveters, feeders, transfers and controls for the particular assembly involved. Equally important are superior knowledge and experience in the design, tooling and application of Multi-Head Riveters because these are usually employed.

TRS originated Multi-Head Riveters over three years ago and is the only experienced source of these machines. Further, because this TRS development opened up new possibilities for automating the riveting process, TRS was able to begin three years ago to develop the special experience and application engineers required to fully meet the requirements of the PAR Process.

PAR . . . A New Opportunity to Reduce Direct Labor Charges

With this new help, hundreds of manufacturers . . . large and small . . . can effect substantial savings in direct labor charges, increase production rates, decrease parts spoilage and machine down-time. Look into it now if your product can be riveted, and especially if several rivets are involved.

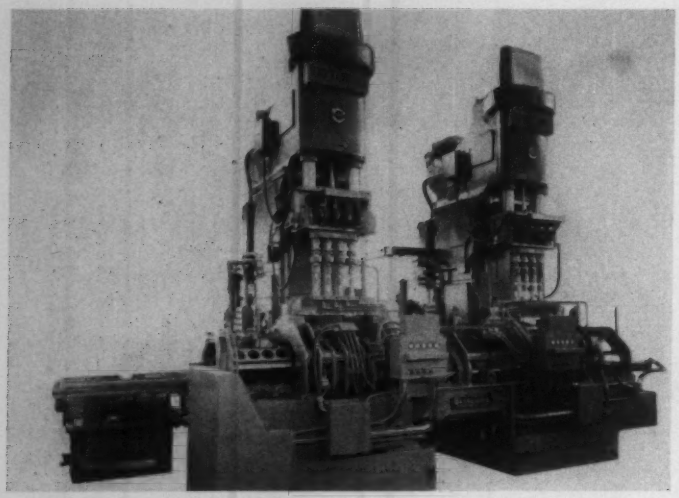
The yearly amortized cost of the TRS Multi-Head Riveter equipment is low because it will not be obsoleted by changes in product design or production line.

To save more . . . To protect against equipment obsolesence . . . don't buy any Riveting Machines until you investigate the PAR Process

You're not required to use TRS Rivets but you'll be better off if you do

There are no contracts or obligations involved in the PAR Process. However, it is true that the more automatic you make your riveting, the more important it is to use rivets that reduce operating troubles and machine down-time. And, we can give you good, factual reasons why TRS Tubular Rivets are more reliable in essential qualities and uniformity. Ask for the facts . . . judge for yourself.

Advt. Copyright by Tubular Rivet & Stud Company, 1958



Vertical Honing Machine Line

Item 406

Two vertical type honing machines (Model 320) are placed side by side and connected by a synchronized automatic trunnion and transfer type fixture to hone the bores of cast iron V-8 cylinder blocks for truck motors. Bore size for one block is 3.625 ID by 5 11/16 inches long. Another part run on the machine has a bore of 3.875 ID by 6¼ inches long. The work cycle, which consists of transfer, load, clamp, trunnion, hone, return trunnion, and unclamp, is automatic.

In operation, a cylinder block is placed in a preloading station, then moved into a fixture in the first machine by a transfer bar. A sensing device in the first station detects the presence of a part and starts the cycle. The part is located in the fixture by pins engaging dowel holes in the pan face of the block. The positioned part is then hydraulically clamped and rotated to place the left bank of bores vertically in the honing position. Simultaneously, a part in a fixture in the second machine is rotated in the opposite direction to permit honing of the right bank of bores.

During normal operation, there are six blocks in the machine: One in the preload station, one in each machine fixture, one in each idle station between the fixtures, and one in an eject station. To clear the machine of parts, the operator presses a *Manual* button on the control panel and directs all machine functions by selecting the proper sequence control. Worn-out honing stones are detected by signal lights on the control panel which indicate when each tool requires new honing stones. **Barnes Drill Co.**, 836 Chestnut St., Rockford, Ill.

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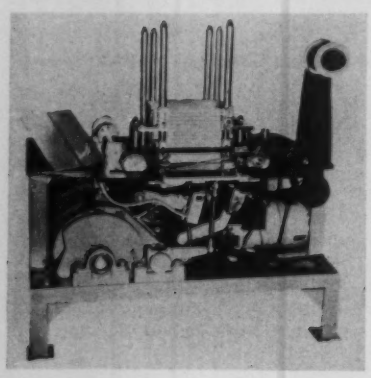
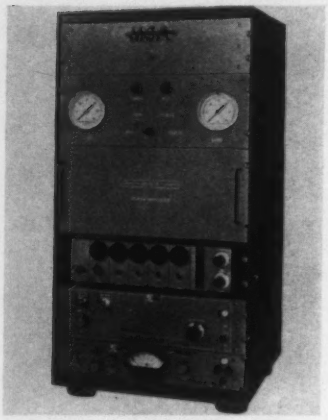


Box Bander

Item 407

Automatic box-banding machine is designed for manufacturers who package their products in set-up boxes. These products include items such as sportswear, linens, games and toys, hosiery, and art materials. In operation, the boxes are automatically fed from a loading position at the rate of 30 per minute to a banding position. There, cellophane tape is wrapped around each box, heat sealed, and cut. A pull tab is provided for easy band removal. The band is applied under tension and remains in the same position on the box despite severe handling. Heat sealable paper and ribbon can also be used to band boxes. **Halm Instrument Co. Inc.**, Dept. LIA, Glen Head, L. I., N. Y.

Circle 407 on Page 17

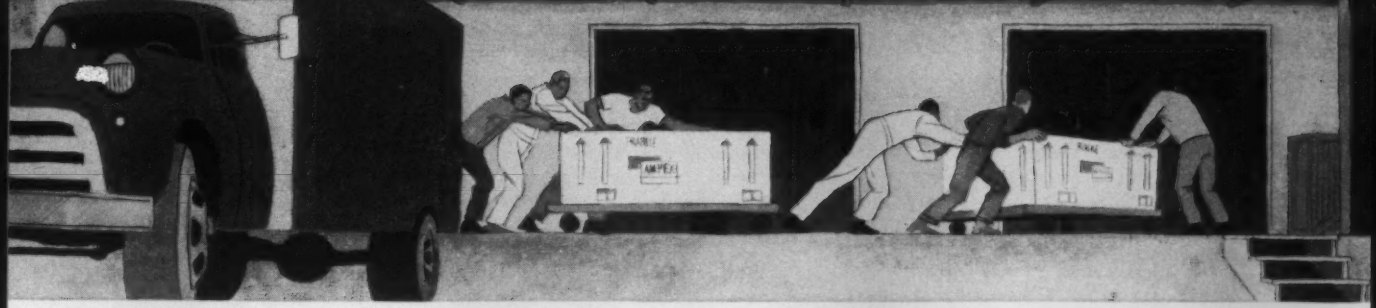


Process Monitor

Item 408

Instrument continuously measures, by volume, the boron content of liquid process streams to within ± 1 per cent. Designed primarily for use as a process monitor for the manufacture of boron-based fuels, the unit can also be used to measure the total boron in liquid process streams for borax production. A neutron absorption principle is used in detecting boron. Thermal neutrons are captured by boron atoms in the stream. These neutrons are produced by a radioactive radium-beryllium wafer and pass through paraffin which slows their velocity to a thermal rate in the sample chamber. The liquid stream then passes between the radioactivve sources and a counter tube filled with boron trifluoride. The boron trifluoride picks up neutrons which pass through boron-free solution, but the presence of boron in the stream decreases the number received in any given time interval.

The neutron capture is indicated by the generation of a current pulse. This pulse is amplified and fed into a scaler which times a preset number of pulses. Boron



Perfect complement to your AMPEX system

. . . your AMPEX Field Service Engineer

Ampex service begins the moment your new equipment comes out of the cases. Whether it is a single FR-100A or a complete digital tape handling system, your Ampex Service Engineer is there on installation day.

He sees to the proper installation of your equipment. He tests it with its original factory checkout tape and specially designed calibration units. And he thoroughly instructs your staff in its operation.

Throughout your warranty period—and afterwards—Ampex Field Service is instantly available for modifications or *fast* replacements, avoiding costly down time.

Minutes after your call to the nearest of 12 offices or to the Ampex Home Office, extra parts or components are on their way. And this same close tie between factory and Field Service keeps Ampex Service Engineers constantly up-to-date on the latest techniques and equipment.

Available are Field Service programs ranging from scheduled preventive maintenance calls or time and materials contracts, to the services of a full-time resident Ampex engineer. With your purchase, an Ampex data specialist will discuss a service and spare-parts plan tailor-made to suit your magnetic tape instrumentation needs.

First in magnetic tape instrumentation

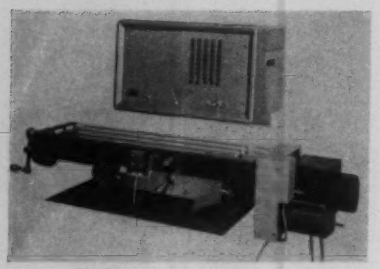
AMPEX
CORPORATION

AMPEX INSTRUMENTATION DIVISION
934 Charter Street, Redwood City, California
Offices in USA and Canada. Engineering representatives cover the world.

Circle 678 on Page 17

concentration becomes a function of the time required to count this number of pulses. From the scaler, the pulse signal is sent to a pneumatic system where it is converted to air pressure and recorded in terms of boron concentration. **Mine Safety Appliances Co.**, 201 N. Braddock Ave., Pittsburgh 8, Pa.

Circle 408 on Page 17

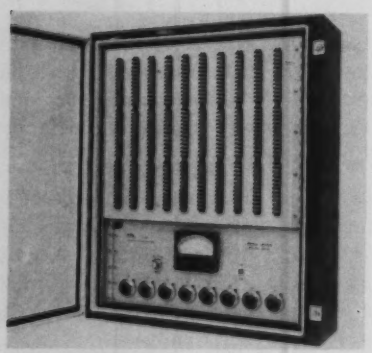


Positioning System

Item 409

Numerically controlled positioning system for machine tools is of building-block design. All positional distances in translation are measured and set in inches and decimals, and are on an absolute basis. Typical performance range is 99.999 inches in steps of 0.001-inch. Accuracy and repeatability are within 0.00025-inch. System is available in an automatically controlled type for 1-inch punched paper tape and in pushbutton keyboard types for manual setup. **Wang Laboratories Inc.**, 37 Hurley St., Cambridge 41, Mass.

Circle 409 on Page 17

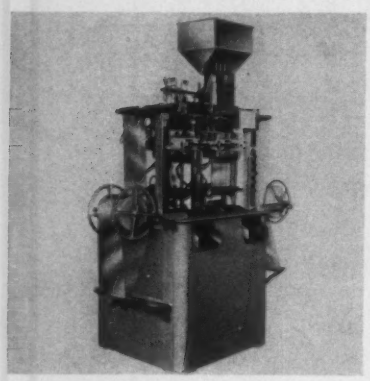


Analog Computer

Item 410

Model CM-2 is a completely solid-state computer which is applicable for computation and control of variables in chemical, petrochemical, refining, and process industries. The analog computer consists of operational amplifiers, logarithmic networks, and scaling potentiometers. Transistors and magnetic amplifiers are used in place of vacuum tubes. Over-all accuracy of the unit is said to be better than 2 per cent. The cabinet of the computer can house up to 12 operational amplifiers, 6 logarithmic networks, and 8 scaling potentiometers. **Southwestern Industrial Electronics Co.**, 10201 Westhiemer, Houston 19, Tex.

Circle 410 on Page 17

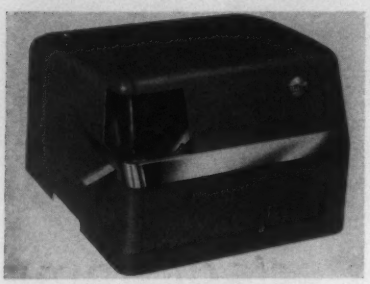


Liquid/Powder Packager

Item 411

Designed to handle either powders or liquids, Model II can produce up to 8 packets per cycle and up to 300 packets per minute. Powder filling is by volumetric or auger feeders which handle free-flowing granular and hygroscopic powders. When mixed filling is required, two different powders can be inserted into each packet by means of divided hoppers. Liquid filling is by piston pumps, features a vacuum cycle which gives sharp product cutoff and is said to eliminate stringers and leakers. Free-flowing viscous and semiviscous liquids can be handled. The packets are sealed on all sides and can be produced from continuous rolls of films, foils, papers, laminates, and other heat sealable materials. Photoelectric cells register printing on both sides of each packet. The packets can be delivered in perforated strips, joined, or individually. **Brown Filling Machine Co. Inc., Div., Franklin Research Corp.**, Fitchburg, Mass.

Circle 411 on Page 17



Typing Reperforator

Item 412

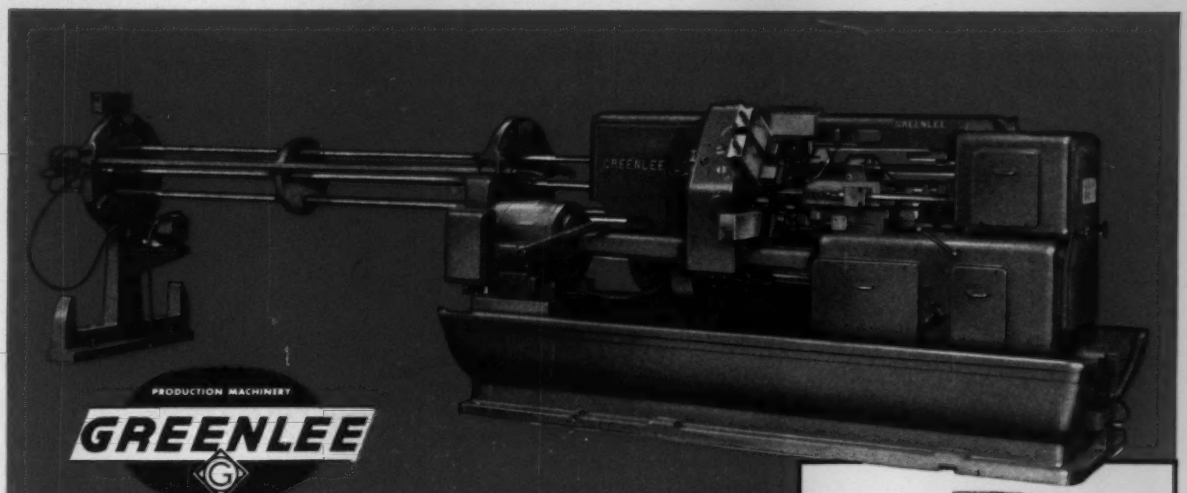
Device consists of a tape punch and printing mechanism actuated by incoming line signals to perforate information in tape while simultaneously printing on tape. Model 28, Type LPR is a receiving unit only, can operate at 100 wpm. Printing and perforating occur simultaneously in every operating cycle of the unit with the printed character being imprinted 6 characters behind the punched code hole as the tape is being read from left to right. Operation of the instrument is completely automatic, except for the necessity of replenishing the tape supply. Power requirements for the unit are 65 w, 115 v, 60 cycles ac. **Teletype Corp.**, 4100 Fullerton, Chicago 39, Ill.

Circle 412 on Page 17

Cold-Heading Machine

Item 413

Unit is designed for quick and accurate cold-heading of small parts such as contacts, rivets, and pins. Model 00 is a double stroke heading machine which will handle parts as small as 0.012-inch in diameter by 0.016-inch in length. The maximum wire diameter handled is 0.070-inch with most alloys and up to 0.120-inch with soft aluminum. Part length can range from 0.016-inch to 0.400-inch. Production rate for a cycle which includes cutting to length, heading, and forming, is between 80 and 120



PRODUCTION MACHINERY

GREENLEE

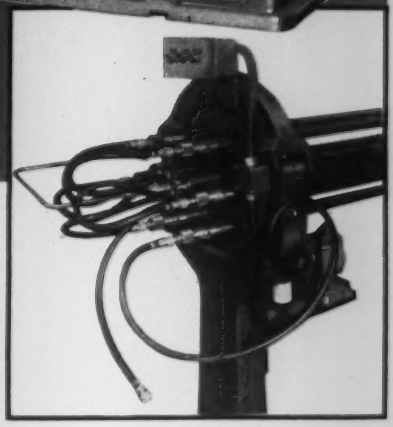
MULTIPLE FEED-OUTS...

A Natural

on Greenlee Air-Feed Automatics

Feed Out Stock to 16½"

Eliminate Pushers and Feed-Out Cams



Removable fittings attach air lines to the stock reel tubes. A vacuum pump withdraws the piston when restocking. Push-button control panel is provided for starting and stopping.

Greenlee Air-Feed Automatics offer you a 3-way profit advantage:

1. Maintenance and change-over time is reduced by eliminating stock pushers, feed tubes and feed-out cams.
2. Stock can be automatically air-fed to position in one or more machining stations permitting two or more pieces per cycle.
3. Multiple feed-out flexibility enables you to finish machine a variety of pieces that ordinarily demand costly second operation setups.

If you are running into production headaches on a specific job, Greenlee may be able to adapt an "Air-Feed" to solve your problem. See your Greenlee Distributor.

Write for your copy of Catalog A-405 — first step on the way to more profitable production with Greenlee Automatic Bar Machines.

• • •

Greenlee Standard and Special Machine Tools

Multiple-Spindle Drilling and Tapping Machines

Transfer-Type Processing Machines

Six and Four-Spindle Automatic Bar Machines

Hydro-Borer Precision Boring Machines

Die Casting Machines

GREENLEE BROS. & CO.

1741 MASON AVE.
ROCKFORD, ILL.

Circle 679 on Page 17

pieces per minute. **Robert E. Morris Co.**, 5004 Farmington Ave., West Hartford, Conn.

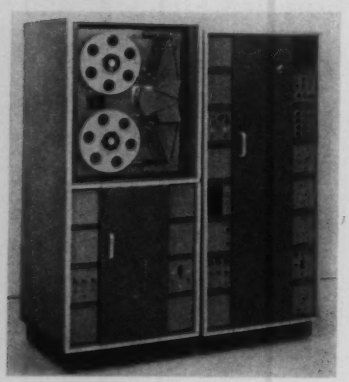
Circle 413 on Page 17

Air Dryer/Receiver

Item 414

Suitable for use in air-controlled and operated units, compressed air dryer and receiver has a two-fold function. It can purify and dry air and store it for use. Unit delivers the air clean and free of moisture to overcome corroding and freezing of instruments, air tools, controls, and pneumatic circuits. The unit operates without heat, regeneration, or regulation, is said to have no volume loss and less than 1 per cent pressure drop. Capacities are up to 8000 scfm and 6000 psig. **Van Products Co.**, 5806 Swanville Rd., Erie, Pa.

Circle 414 on Page 17

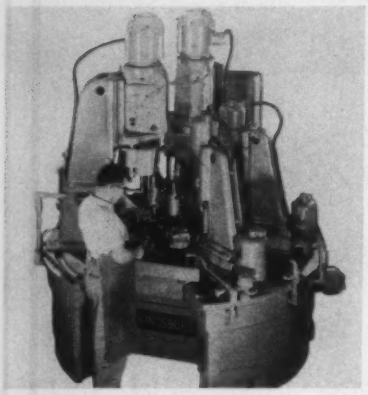


Digital Processor

Item 415

Instrument can convert, program, and record analog signals in digital form on magnetic tape at rates up to 10,000 samples per second. Unit, designated Micro-Sadic, consists of a commutator, digitizer, system programmer, time programmer, and digital tape unit. The outputs are recorded on digital magnetic tape in preselected formats. Digitizing can be in either bipolar binary or bipolar binary-coded decimal form. Unit is mounted in two cabinets. In the illustration, the cabinet at the left contains the tape transport, the one at the right contains the electronic equipment. The circuitry is mounted on clip-in printed wiring boards for easy maintenance. **Consolidated Electrodynamics Corp.**, 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle 415 on Page 17

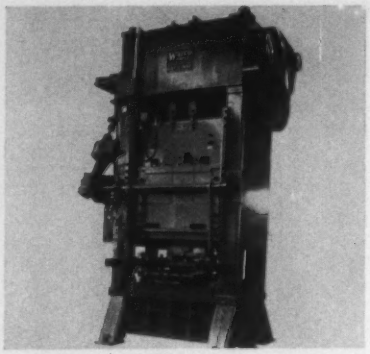


Automatic Drilling Unit

Item 416

Machine has six units with a total of 12 spindles which drill and countersink cross holes in 11 different steel pins. Pin diameters rang from 9/16 to 7/8-inch, and lengths up to six inches can be accommodated. A 20-inch, index table holds seven work fixtures. The fixtures hold two parts at a time. Drilling is in four steps, by two large vertical units. Each drilling unit has a four spindle auxiliary head. To countersink both the tops and bottoms of pins, two of the machining units have attachments that operate from underneath the fixtures. Each unit with its attachment operates on one part in each fixture. Production rate is from 1160 to 1765 parts per hour, depending on the size of the pin. **Kingsbury Machine Tool Corp.**, Keene, N. H.

Circle 416 on Page 17

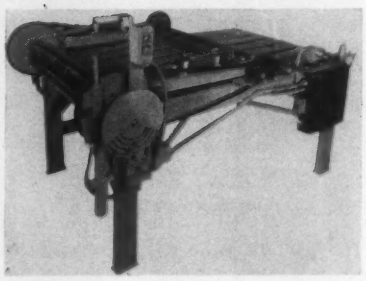


Hot Parts Feeder

Item 417

Shuttle type feed unit is designed for use with company's double-eccentric shaft, straight sided presses. It can automatically feed hot plowshare blades to form, coin, pierce, and countersink press stations. It also ejects parts automatically. The feeding unit carries the hot blades from a receiving station in front of the press to a work station; after the press operation, the feeder removes the piece and releases it to a discharge chute leading to an oil bath. A pneumatic clutch and brake unit on the press has a pushbutton electrical control panel. The positions which control the press operation are *Off*, *Inch*, *Short*, and *Continuous*. **Federal Machine & Welder Co.**, Warren, Ohio.

Circle 417 on Page 17



Sheet Metal Bender

Item 418

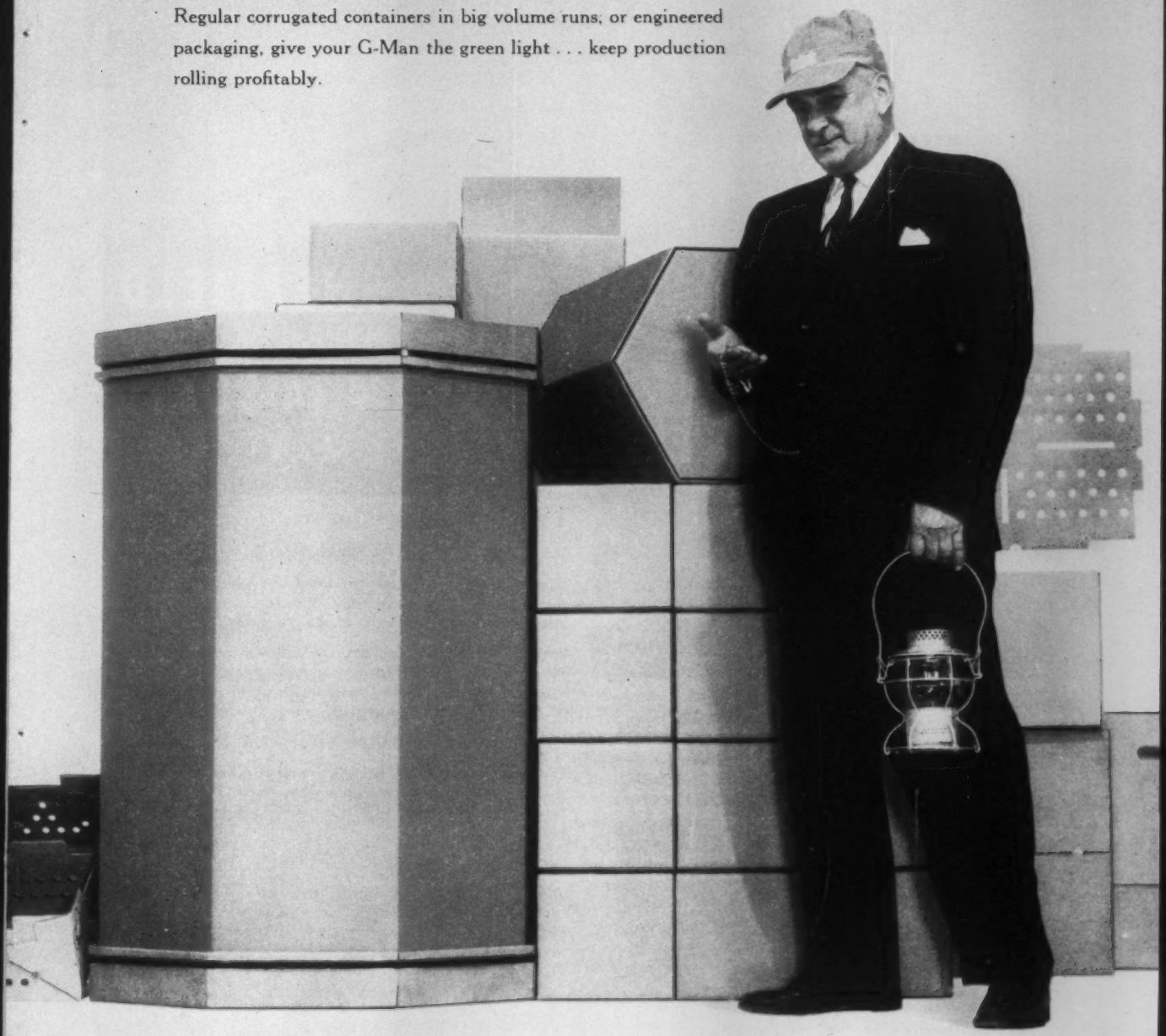
Equipment can bend sheet metal up to 180 degrees with a radius of bend from 1/4-inch to 3 inches. It will handle sheets up to 42 inches wide. In operation, a pushbutton control automatically clamps the material, rolls the sheet around a mandrel to any desired degree of bend, returns the roll, and releases

Circle 680 on Page 17→

GAYLORD DEPENDABILITY
KEEPS YOUR PRODUCTION ROLLING

You get a clear track to corrugated boxes when you signal Gaylord to start the run. In all lines of industry, Gaylord has a well earned reputation for delivering the packaging . . . so you can package and deliver the goods . . . on schedule.

Regular corrugated containers in big volume runs, or engineered packaging, give your G-Man the green light . . . keep production rolling profitably.

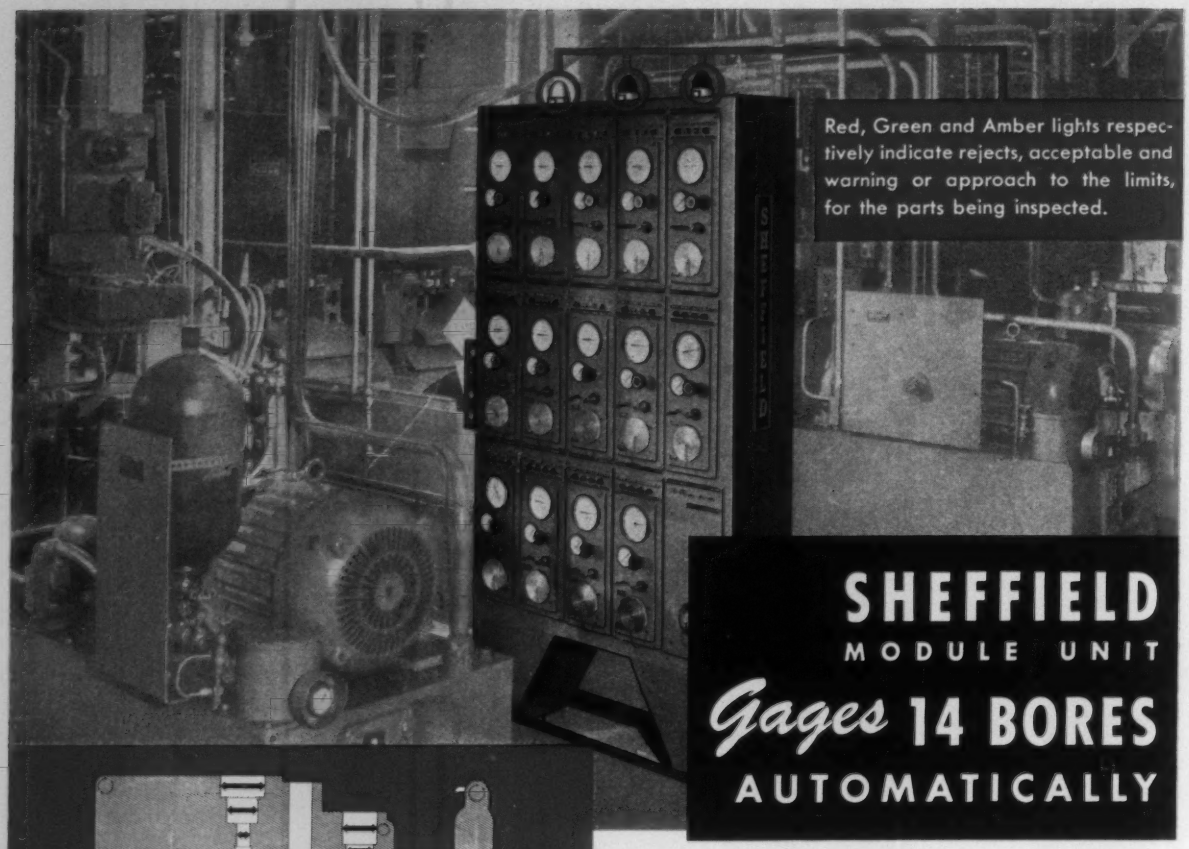


GAYLORD
CONTAINER CORPORATION

Gaylord Boxes

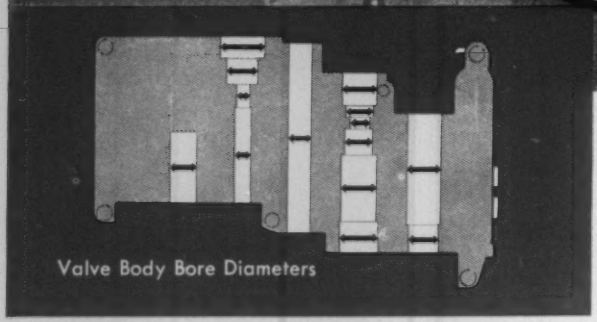
HEADQUARTERS, ST. LOUIS
PLANTS COAST TO COAST

DIVISION OF **Crown Zellerbach Corporation**



Red, Green and Amber lights respectively indicate rejects, acceptable and warning or approach to the limits, for the parts being inspected.

SHEFFIELD MODULE UNIT *Gages* 14 BORES AUTOMATICALLY



Valve Body Bore Diameters

Transmission valve bodies directly from the boring machines are conveyed to gaging position. Air gaging spindles enter simultaneously to explore the dimensional fitness of each bore and to detect any possible obstruction such as a broken tool fragment.

The results of the pneumatic check are transformed into visual signals and electrical impulses—the latter for use in the automatic control of the boring machines.

Quicker, More Convenient to Adjust

The compact mounting panel carries an individual Sheffield Modulaire* for each dimension gaged. All adjusting elements and controls including the air pressure gage and visual indicator are right on the front of each Modulaire unit where they are most accessible and visible.

*Trademark

Servicing Greatly Simplified

Each Modulaire is a self-contained unit which may be slipped out of the assembly and replaced without interfering with other units of the assembly.

Each group of Modules is provided with a Sheffield Monitorecord Circuit for quickly checking the time cycles of the gaging functions. This is an integral part of every Sheffield Automatic Control System.

Longer Tool Service Life

Sheffield air gage spindles are designed with greater hole clearance to minimize wear. They float for slight differences in bore location and thus further extend service life.

Not Confined to Air Gaging

The sensing units of Sheffield automatic gages may also be electronic, electrical or mechanical as well as pneumatic. The choice depends on individual requirements or restrictions. Sheffield builds gages of all types as well as data handling systems.

8194

the SHEFFIELD corporation
of Bendix Aviation
manufacture and measurement for mankind

When you are considering an installation of this type, call a Sheffield engineer. His recommendations need not be biased. Or write the Sheffield Corporation, Dayton 1, Ohio, U.S.A. Dept. 3

the clamp. The desired radius is obtained by changing the mandrel, and the degree of bend is preselected by moving a handle. **Klaas Machine & Mfg. Co.**, 4314 E. 49th St., Cleveland 25, Ohio.

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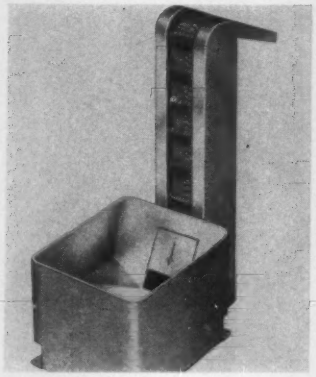

Elevating Conveyor

Item 419

Vertical elevating conveyor can be loaded from the floor level. The bin hopper capacity is 5 cu ft. Bin has drilled footings for securing and leveling. An outlet door in the bin is adjustable to control the flow of parts to the conveyor belt. A paddle type relay switch arm automatically starts and stops the flow of parts to a feeder bowl. A feature of the conveyor is use of self-cleaning cleats which eliminate snarling or nesting of parts. **VFC Div., Automation Devices Inc.**, 3125 Brandes St., Erie, Pa.

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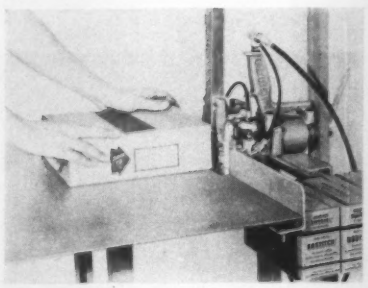

Sidestroke Stapler

Item 420

Unit is an air-driven stapling machine which is capable of fastening flaps of corrugated containers entirely from the outside. It can seal partial overlap, full overlap, telescope, small regular slotter containers, or five-panel folders. Model D14ADS-1 drives a 1¼-inch wide-crown staple with every push of a box against an automatic trip bar. A quick-adjust knob allows setting of staple penetration depth and automatically adjusts tightness of the clinch. There are eight possible knob positions providing closure control from a full clinch with maximum penetration to a shallow, blind clinch. The stapling head can be rotated 90 degrees to apply staples vertically across the center seam of regular slotted containers. **Bostitch**, 2027 Briggs Dr., East Greenwich, R. I.

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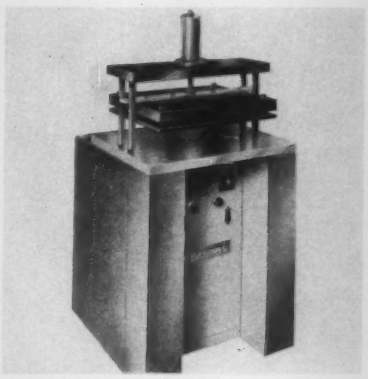


Plastic Sealer

Item 421

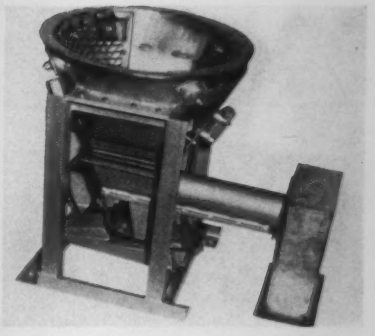
Model C-64 is suitable for use with either precut assembly materials or for progressive feed-through operations. The floor mounted unit has 1500 lb platen pressure and the capacity is up to 70 lineal inches of tear seal. Platen area is 15 by 24 inches. Other features of the sealer include insulated dies and a self-tuning electronic circuit. Unit is rated for 220 v, single phase power, and requires an air supply at 80 to 120 psi. **Reeve Electronics Inc.**, 609 W. Lake St., Chicago 6, Ill.

Circle 421 on Page 17

Antibridging Vibrator

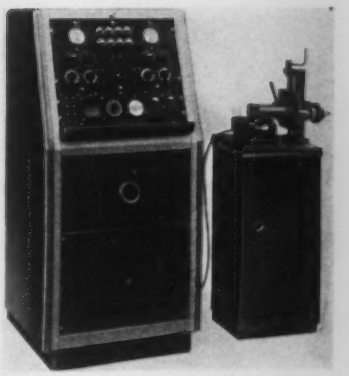
Item 422

Vibrator is capable of eliminating bridging of materials in storage bins, supply ducts, and containers; is applicable in weighing operations where a constant flow of material is required between



storage hoppers and scale feeders. The vibration is applied to screens which are inserted within the chamber of the hopper and extend downward to the lower opening or discharge outlet. In this manner, a small mass of steel is agitated to break the bridge of the material between the side walls of the container. The breaker is available in mild steel, stainless steel, and Teflon coated steel. Breakers are available separately, or hopper sections can be furnished with flanged inlets and outlets for attaching to existing storage bins and ducts. **Thayer Scale Corp.**, Thayer Park, Pembroke, Mass.

Circle 422 on Page 17

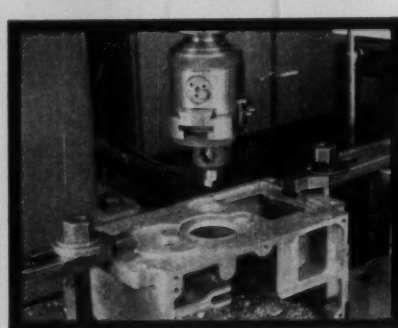


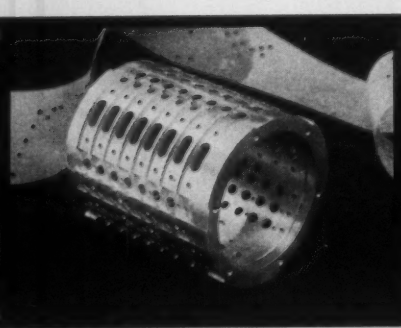
Nondestructive Tester

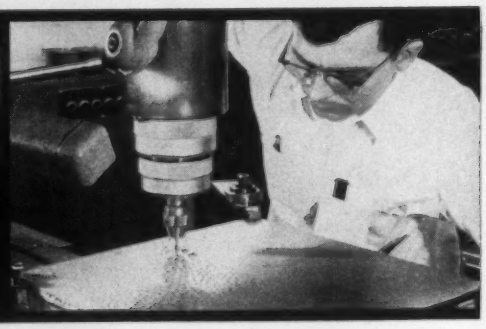
Item 423

Machine is adaptable for production line testing of tubing, bars, and wire for surface and subsurface defects, grade, dimensions, and physical and metallurgical properties. Types of metals which can be tested by the eddy current process include aluminum, titanium, zirconium, copper, copper-nickel alloys, brass, high-temperature alloys, and austenitic stainless steels. Inspection speeds range from 200 to 600 fpm. Coils

ACCURACY







MACHINING TIME WAS CUT 50% for 10-piece lots of these gear boxes, by changing from manual to tape control. Locations made automatically under tape control are accurate to .0001".

30-HOUR JOB DONE IN 7½, when this precision computer part was machined under Numerical Control. This job involved precision machining at 566 separate locations.

1429 HOLES WITHOUT ERROR, an almost impossible job under manual operation, was completed under Pratt & Whitney Numerical Control with estimated time savings of 41%.

ASSURED...

"P&W NUMERICAL CONTROL HAS PROVED IT WILL IMPROVE **MACHINE UTILIZATION*** 100% AND ELIMINATE ERRORS," says "Jake" Jaeger

**(Time spent cutting metal)*

Mr. J. J. ("Jake") Jaeger, Vice President and Chief Engineer of Pratt & Whitney's Machine Tool Division, states, "Reports from more than 35 successful installations in the field and experience in our own manufacturing conclusively prove that P&W Jig Borers with Numerical Control represent a truly significant advance in metalworking. Users, which include both the giant corporations and shops with less than 10 men, are realizing time savings from 2-to-1 to 6-to-1 – depending on the complexity of the parts – and in addition have improved their MACHINE UTILIZATION time 100%. With this great increase in productivity, the jig borer has truly become a production machine. Used, for example, in our own manufacturing of components, the need for expensive jigs is eliminated, engineering changes are simple and inexpensive – and every production part has the toolroom precision of an original jig.

ADDITIONAL ECONOMIES THROUGH SCRAP ELIMINATION . . .

"With all machine positioning made automatically under Numerical Control, scrap losses from human errors in positioning are eliminated. Freed from blueprint calculating, the operator can concentrate on his primary job – making chips. The result is more and better work, with less fatigue.

VERSATILITY UNLIMITED

"The P&W Jig Borer has also proved that it can handle efficiently and economically an almost unlimited variety of jobs – one-piece jobs, extremely complex jobs, or lot production – in fact, any job that requires drilling, reaming, tapping or boring holes, or milling slots or surfaces."

Summing up the importance of Numerical Control, "Jake" Jaeger continues, "No one can *afford* to overlook the ability of this equipment to increase machine tool utilization and effect economies in his own operations." Experience has proved the truth of this statement, so act today to get all the facts on P&W Numerical Control. Write now for your free copy of Circular No. 609. Pratt & Whitney Company, Inc., 35 Charter Oak Boulevard, West Hartford, Conn.

PRATT & WHITNEY

FIRST CHOICE FOR ACCURACY

MACHINE TOOLS • GAGES • CUTTING TOOLS

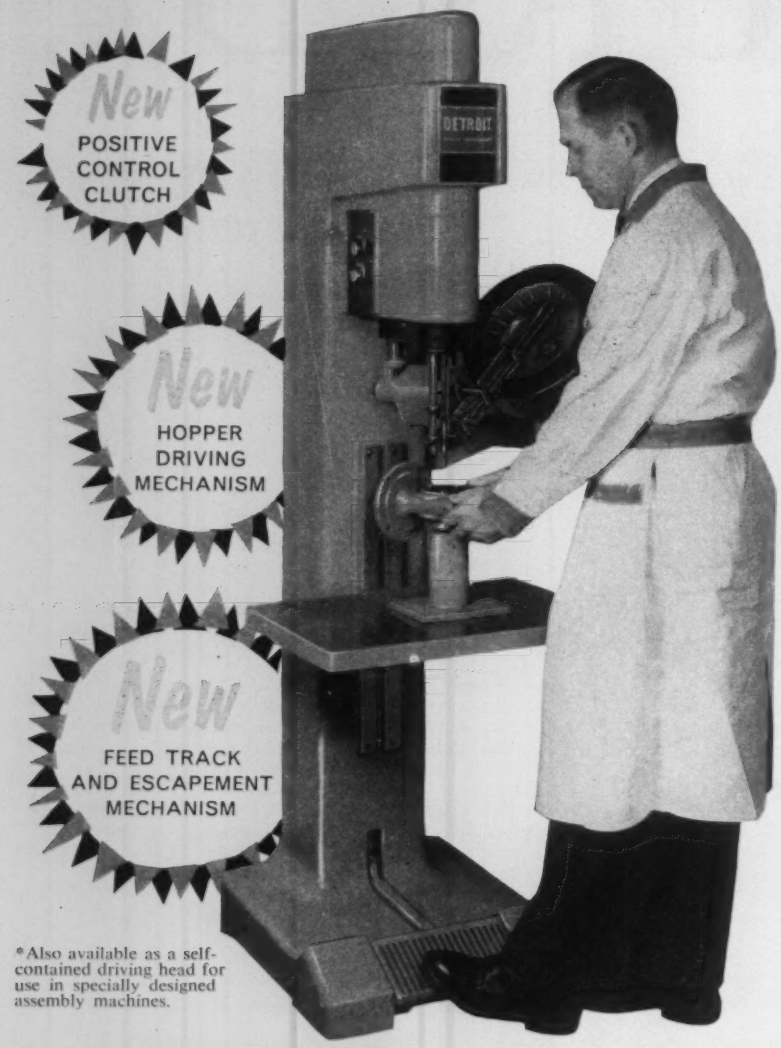
AUTOMATICALLY POSITIONING WORK ACCURATE TO .0001", the P&W Numerically Controlled Jig Borer combines toolroom precision with production-line speed and economy.

SETTINGS ACCURATE TO 5 SECONDS OF ARC are made automatically by the P&W Rotary Table with Numerical Control. Automatic positioning speeds work, eliminates human errors.

PROFILE MILLING ENTIRELY UNDER TAPE CONTROL, the P&W Numeric-Keller produces irregular shapes without the need for any template or model. Accuracy is unusually high.

Circle 682 on Page 17

ALL NEW . . . through and through!



*Also available as a self-contained driving head for use in specially designed assembly machines.

The DPS model U power screwdriving machine

Manufacturing assemblies with small parts? Take note! Detroit Power Screwdriver Company announces the totally new Model U—quickly adaptable for fast, clean driving of screws, nuts and studs.

Scores of advances! An adjustable clutch designed to hold constant driving torques. A hopper drive with built-in slip control to accommodate shock loads. A feed track with quickly adjustable covers, and an escapement mechanism with positive solenoid action permitting release of screw by body or head.

A new folder, too. Write for your copy today.

DETROIT POWER SCREWDRIVER COMPANY 15,033

2811 W. Fort St. • Detroit 16, Michigan

A Subsidiary of Link-Belt Company

Circle 683 on Page 17

are available for testing material from ⅛ to 3 inches OD.

Two frequencies operate simultaneously, with two flaw detection circuits and one property variation detection circuit for each frequency. Dual frequency operation, plus a total of six inspection methods, permits simultaneous detection of a wide variety of flaws and property variations. **Magnetic Analysis Corp.**, 42-44 Twelfth St., Long Island City 1, N. Y.

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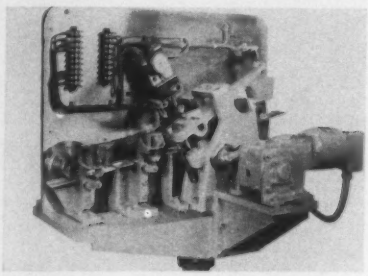


Gear Gager/Sorter

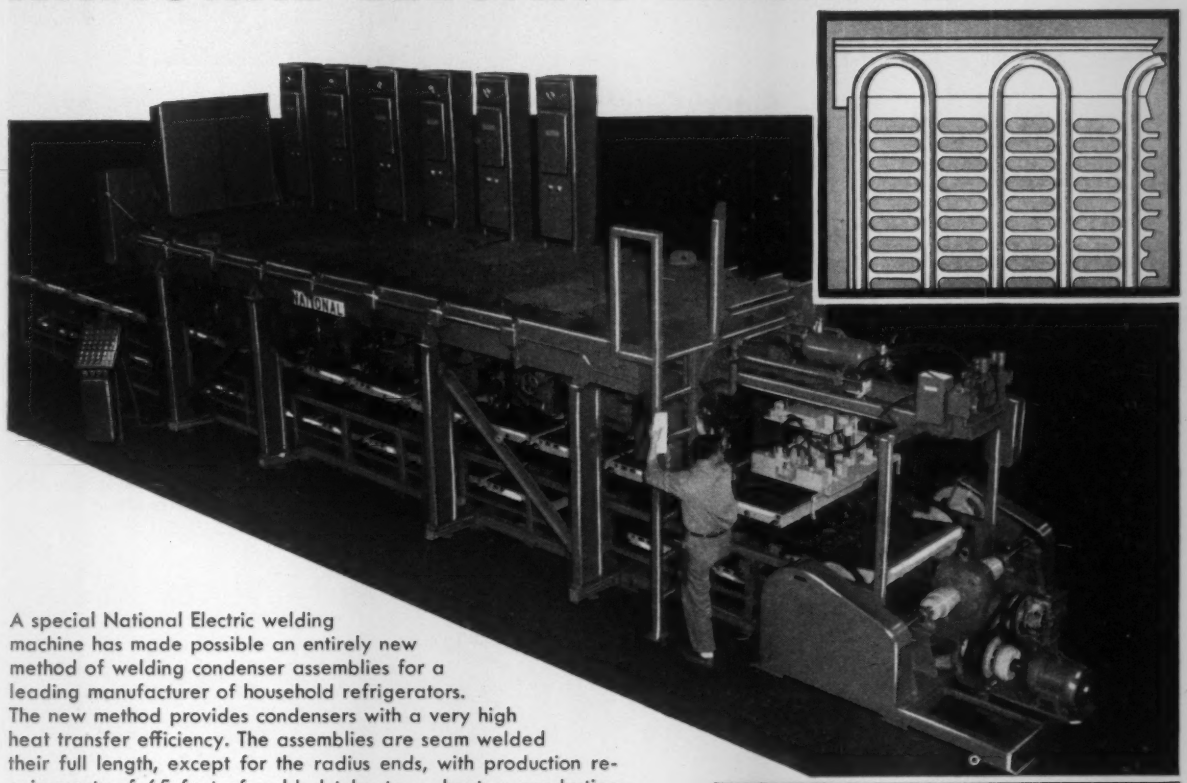
Item 424

Automatic gear gaging and sorting machine checks the accuracy of gears with large integral flanges which have been produced by hobbing, shaping, or shaving operations. In operation, the flanged gear rolls through the gage on a guide rail that supports the gear on the hub surface between the gear and the flange. Another guide rail behind the gear bears on the flange surface and keeps the gear upright until it is engaged by a master gear. One gear at a time rolls into mesh with a motor driven lower master gear that raises the gear from the lower rail for the checking operation. The upper master gear, which is on a spring-loaded, pivoted beam mechanism, squares up the gear as it passes between the master gears for the size check.

The amount of deflection of the upper master gear is accurately measured as the gear passes through to determine the size of the gear teeth. Gears of correct tooth size pass into the gage exit chute and on to the production line. Gears that are oversize or undersize drop into a trap door in the gage's exit chute. **National Broach & Machine Co.**, 5600 St. Jean Ave., Detroit 13, Mich.

Circle 424 on Page 17

THREE HUNDRED new type refrigeration condensers welded per hour with NATIONAL ELECTRIC MACHINE



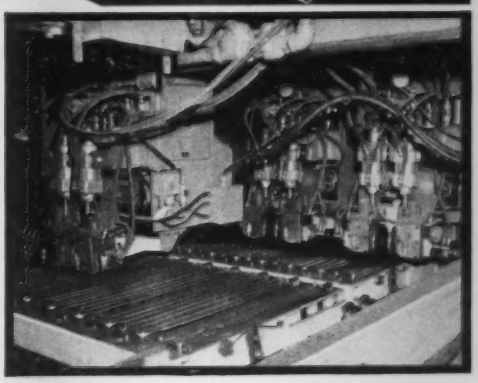
A special National Electric welding machine has made possible an entirely new method of welding condenser assemblies for a leading manufacturer of household refrigerators. The new method provides condensers with a very high heat transfer efficiency. The assemblies are seam welded their full length, except for the radius ends, with production requirements of 65 feet of welded tube to a sheet, a production rate of 300 condensers per hour and a total of 9,700 feet of seam welding to be done per hour. The weld itself is the joining of a tube ¼" O.D. by .028 wall thickness to a formed sheet .010" to .014" thick.

To meet these requirements, National Electric Welding Machines Company designed and built a special Multi-Station Resistance Welding Machine with 34 seam welding wheels and 17 welding transformers, each transformer rated at 70 KVA.

In operation, formed tube is loaded by an operator on to one of 36 carriages traveling at a constant welding speed. (The sheet is automatically received from its forming machine.) Sheet and tube then move through the 16 welding stations. (A 17th is utilized as a standby.) The complete seam welded assembly is removed from the carriage by electro magnets and dropped to an unloading conveyor.

If you have a production welding problem, National Electric can develop an automatic welding machine for you that will assure higher production and lower cost per weld. Write today for complete information.

56



NATIONAL
Electric welding machines co.
1870 N. TRUMBULL STREET
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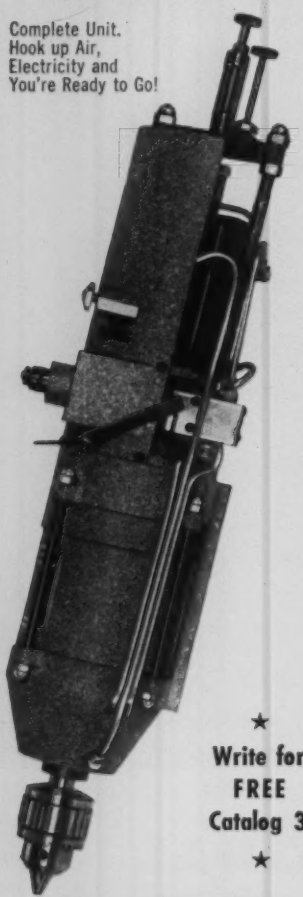
• COMPACT! ..... POWERFUL!
... up to 3 HP in a 6" Frame..
... up to 10 HP in an 8" Frame
Complete Unit.
Hook up Air,
Electricity and
You're Ready to Go!



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Catalog 30
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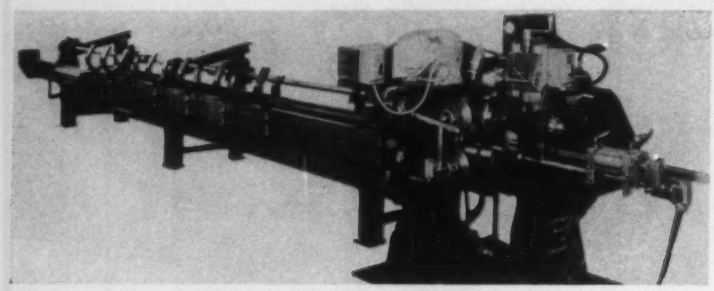
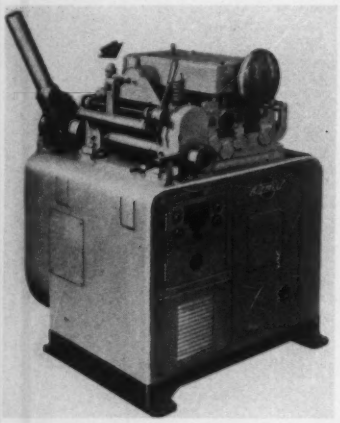


Rotary Cutoff Machine

Item 425

Equipment is capable of automatically feeding and cutting pipe and tube lengths to predetermined lengths. In operation, the rack is loaded with from 15 to 25 lengths of pipe up to 21 feet long. A length of pipe is automatically lifted from the rack into support forks, and pushed into feed rollers that convey the pipe to an automatic stop gage where the cutting action starts. The actions of an air-cylinder pusher, feed rollers, and cutter are electronically co-ordinated. Adjustments can be made for cutting pipes from $\frac{7}{8}$-inch to $3\frac{1}{2}$-inch OD. **Continental Machine Co.**, 2345 W. Nelson St., Chicago 18.

Circle 425 on Page 17

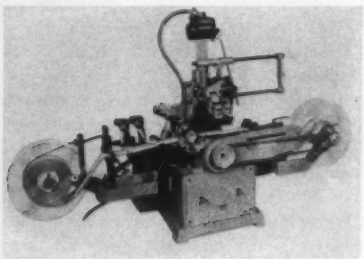


Feeder/Straightener

Item 426

Hydraulic, rack and pinion feeding and straightening machine features an automatic roll lifter which makes the unit adaptable to progressive die work. The roll lifter is operated by air and is electrically actuated by the ram of the press. The roll lifting operation is automatically co-ordinated into the straightening-feeding cycle. The cycle is timed so that the upper rolls are lifted clear of the stock, permitting pilots to locate the stock perfectly on the die. At the completion of the ram stroke, the upper rolls are automatically lowered to normal position in contact with the incoming stock to be straightened and fed in the next cycle. **F. J. Littell Machine Co.**, 4101 N. Ravenswood Ave., Chicago 13, Ill.

Circle 426 on Page 17



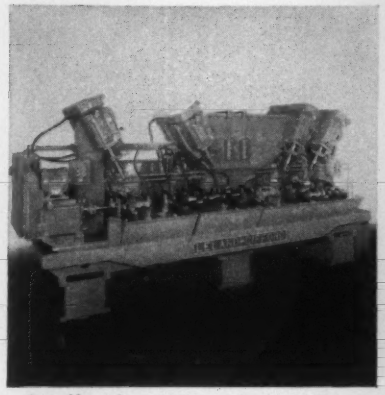
Label Printer

Item 427

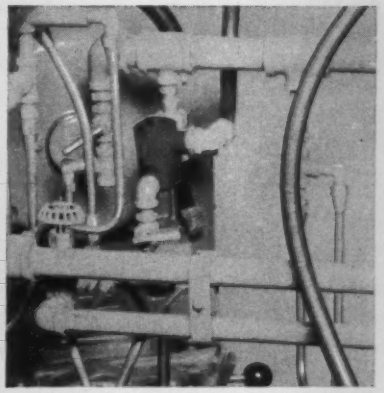
Machine can print or overprint on die-cut pressure sensitive paper, gummed paper, and various types of labels that are in roll form. The stock is fed from a roll, printed or imprinted and then either rerolled, perforated and rerolled, or cut and stacked. Operating speeds from 70 to 100 labels per minute can be obtained, depending on the label material and size. Model 126AF can also be equipped with an automatic counter which stops the machine when a preset number of labels has been printed, or with a reset counter to indicate the number of labels printed. **Markem Machine Co.**, Keene 64, N. H.

Circle 427 on Page 17

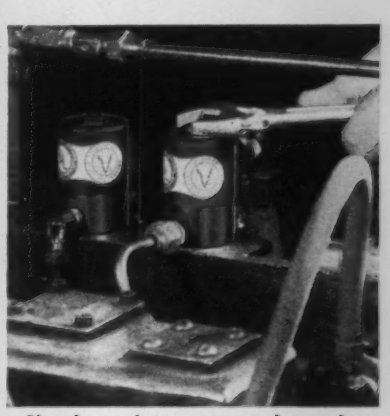
Why Skinner V5 solenoid valves are solving so many control problems



Application: The Leland-Gifford nine-unit hydraulic drilling machine used for drilling crankshafts uses two-way Skinner V5 valves to control the flow of coolant at each operating station of the fixture.

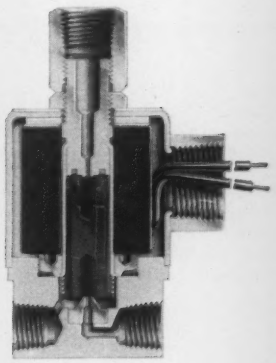


Automatic coolant operation: The Skinner V5 2-way normally closed valves are wired so that at the start of the drilling operation the valves are energized causing coolant to flow before the drill starts its drilling pass. When the cycle is complete the drill retracts, the valves are de-energized and the flow of coolant is halted.

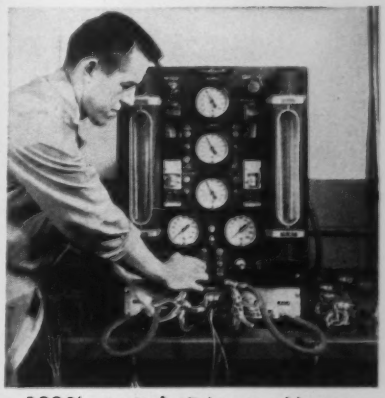


Simple maintenance and repair: The design of Skinner V5 valves permits hand disassembly for cleaning without removal of the valve from the line. Coils, housings, plungers, sleeves are interchangeable and easily replaced.

Skinner stainless steel V5 valves are offered in two- and three-way construction, normally open, normally closed, directional control, multi-directional, quick exhaust. Orifices: 1/32″ to 3/8″; NPT ports: 1/8″, 1/4″, and 3/8″; pressure ratings: to 3000 psi. Explosionproof models UL approved for both Class 1, Group D and Class 2, Groups F and G are available.



Engineered to highest UL standards: Body and internal parts of *frequently copied* V5 valve are stainless steel and, thus, corrosion-resistant. Durable, compressible inserts of soft synthetic materials insure bubbletight operation. Orifice seats have radius with well-rounded contact area and high finish for long insert life.



100% tested. Prior to shipment, every V5 valve is tested for both internal and external leakage under full pressure conditions with modern, sensitive detecting equipment. In these laboratory tests Skinner V5 valves regularly get over 20-million cycles without leakage. And these results are constantly proving out in service.

Skinner solenoid valves are distributed nationally.

For complete information, contact a Skinner Representative listed in the Yellow Pages or write us at Dept. 323

SKINNER ELECTRIC VALVES

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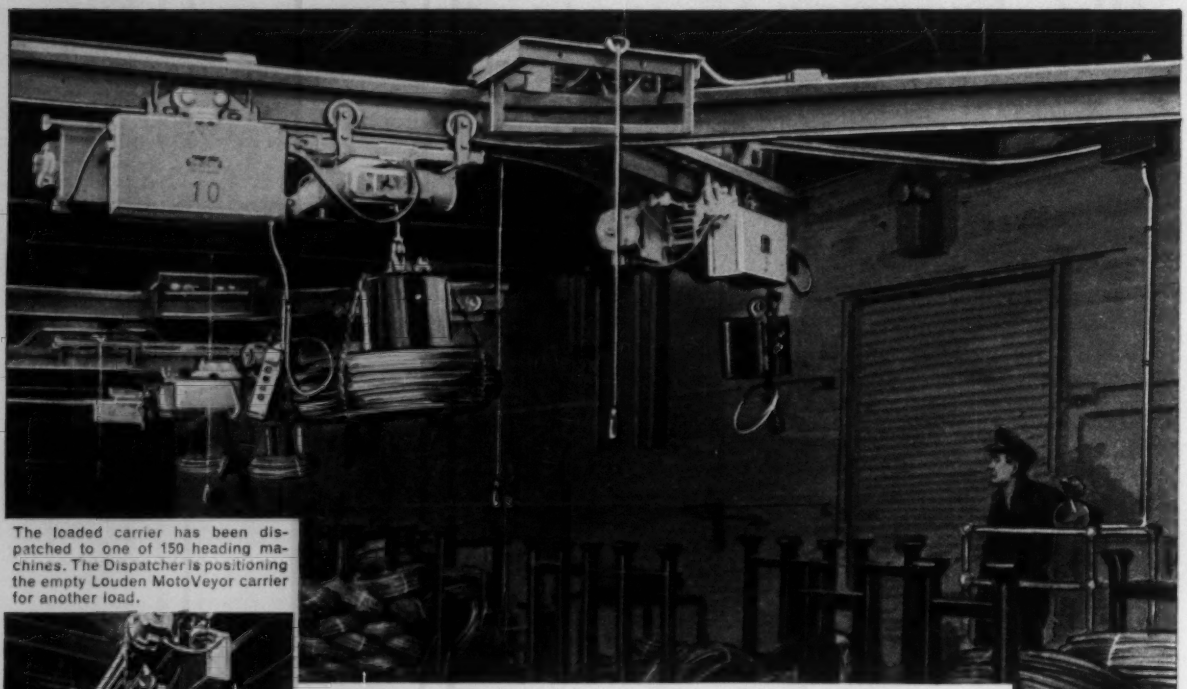
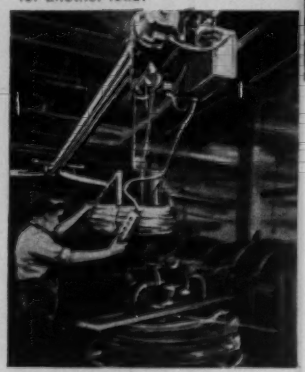
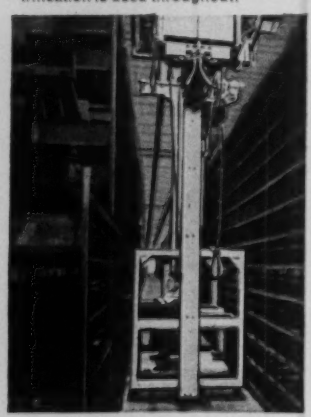
Circle 686 on Page 17



The loaded carrier has been dispatched to one of 150 heading machines. The Dispatcher is positioning the empty Louden MotoVeyor carrier for another load.



The carrier automatically stops at a selected heading machine, and operator lowers the coil of wire to heading machine reel. After hoist is raised, carrier automatically returns to Dispatch Area. Louden Shok-Pruf Electrification is used throughout.



Two Louden Tiering Trolleys serve each pan storage aisle. View shows Tiering Trolley Operator removing tote pan from storage for transfer to another department. The platform of the motor driven Tiering Trolley raises and lowers enabling the operator full coverage of the storage aisle. Current supplied by Shok-Pruf Electrification.

Industry's Airways UNTANGLE Materials Transport

In planning their new plant at Clifton, New Jersey, the Parker-Kalon Division of General American Transportation Company, manufacturers of self-tapping screws and metal specialties, "took to the air" to end longstanding problems and needless costs in materials handling. Working with Louden engineers, they took advantage of the opportunities offered by monorail overhead handling to coordinate materials supply and manufacturing needs from receiving of raw stock to the shipping of the finished product.

Typical of the improvements made was the handling of stock in the Heading Room. In previous practice, 450 pound rolls of wire were carried by fork truck, one roll at a time, and stacked at one end of the department. When any machine needed wire, the machine operator had to roll a bundle from the supply to the machine, lift it manually and place it on the empty reel. Now Louden equipment ends all this waste of time and the ever present chance of physical injury. Louden handling delivers the stock wherever needed easily, swiftly and safely.

When you have a materials handling problem or plant problem involving lifting and transporting loads, call on Louden for suggestions. Louden's unparalleled experience and proven engineering leadership combined with Louden's broad line of equipment can save time and mistakes. Write or wire today.

THE LOUDEN MACHINERY COMPANY

9603 Broadway, Fairfield, Iowa

A Subsidiary of Mechanical Handling Systems Inc.

Get the latest information on the best in modern materials handling systems. Write today for your copy of "Economical Material Handling," a 52 page book full of how-to-do-it ideas. If you are interested in automation, ask for the new book on Louden Automatic Dispatch, "Automatic Materials Handling." With either you will receive the latest information on Louden Shok-Pruf Electrification, new safety in power for cranes and monorail systems.

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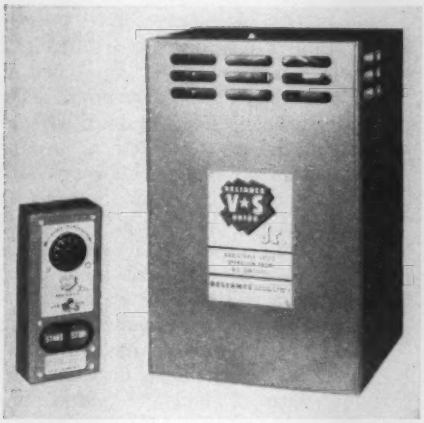
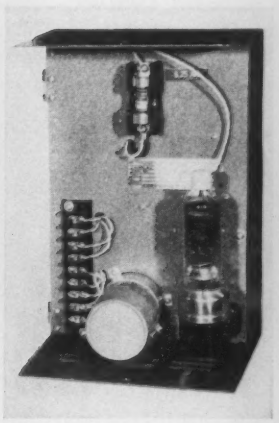
AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

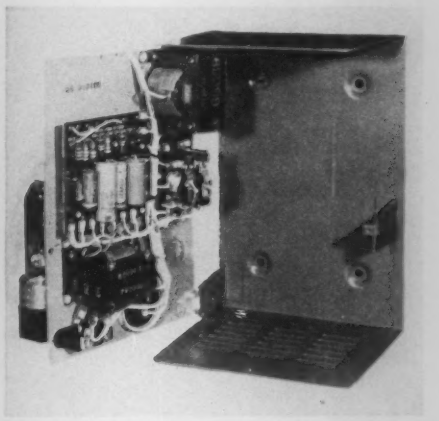
For detailed information and literature, use card page 17.



Operator's station is at the left and the control unit is at the right. The station contains *Start*, *Stop*, and *Jog* pushbuttons.



A single thyratron tube on the control panel provides rectification of standard in-plant ac power for variable-speed drive motor.



Drive panel in the control unit is hinged to permit access to back-of-board-mounted control components.

Thyratron-Powered Variable Speed Drive

Item 428

APPLICABLE for driving such equipment as small conveyors, grinders, printing presses, welding positioners, packaging machines, and light winders; line of variable speed drives is available from 1/8 through 3/4 horsepower, with an 8:1 speed range. It is designed and manufactured by **Reliance Electric and Engineering Co.**, 24701 Euclid Ave., Cleveland 17, Ohio. Unit, designated Fractional V*S Jr., features a single half-wave thyratron electronic tube as the main rectifier. It can operate on standard in-plant single phase, 50 or 60-cycle, 220 v ac power. Complete drive consists of an operator's station, control unit, and variable-speed drive motor. The operator's station houses the *Start*, *Stop*, and *Jog* pushbuttons and a calibrated speed selector. This device can be mounted remotely or at the driven machine.

The control panel is built around a printed circuit board. The panel is hinged for accessibility to all rear-mounted components and the front cover is removable for access to the front of the panel. Variable-speed drive motors are available in drip-proof; totally enclosed, nonventilated; totally-enclosed, fan-cooled; or explosion-proof enclosures.

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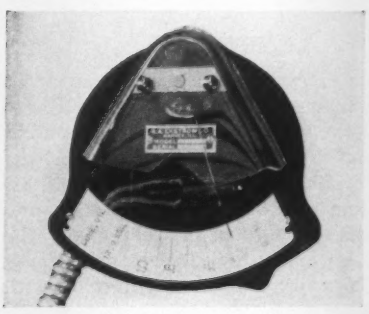


Indicating Vane-Type Flowmeter

Item 429

Indicating vane-type flowmeter features a magnetic follower-pointer permitting flow to be totally enclosed within a pressure-tight metal body. The flow vane in the flow chamber and the indicating scale pointer are coupled magnetically, and can operate switches without creating any objectionable errors in measurement.

Line of instruments is designed for operation in the range of pres-

Line of flowmeters has no mechanical linkage between the flow vane and the scale pointer or switch operating mechanism.

sures from 60 to 2000 psi. Instrument bodies can be furnished in ferrous or nonferrous materials, with the vanes in phosphor bronze or nickel silver. Meters are available for direct installation into the piping in scale ranges up to 10 cfm and 20 gpm. For larger flow applications, shunt-type flowmeter assemblies are available. **Seico Instruments Div., Eclipse Fuel Engineering Co.,** Rockford, Ill.

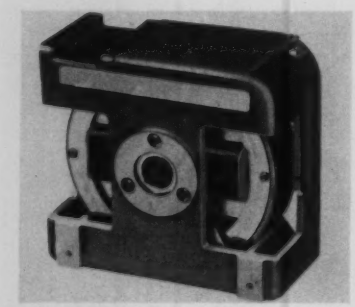
Circle 429 on Page 17

Pillow Block

Item 430

Line of ball bearing pillow blocks is of one-piece construction. Each unit is permanently sealed and prelubricated, ready for assembly on the shaft. The pillow blocks, designated LP Series, are available in the following shaft sizes: 3/4, 7/8, 15/16, 1, 1 3/16, 1 1/4, 1 3/8, and 1 7/16 inches. **Sealmaster Bearing Div., Stephens-Adamson Mfg. Co.,** Ridgeway Avenue, Aurora, Ill.

Circle 430 on Page 17

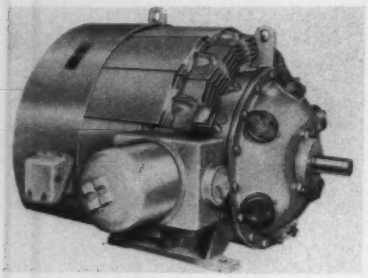


Encoder

Item 431

Suitable for use with company's indicating receiver, device is designed to convert rotary motion to a coded electrical output suitable for long-distance transmission and logging. It can also be used in any operation involving a shaft whose rotation is stopped for short intervals. The coded output is obtained by using a metal-clad plastic disc with readout brushes which are not normally in contact. Closing a readout switch puts the brushes in contact with concentric, printed circuit tracks on the disc and closes another switch which energizes the disc and contacts. This sequence of events is very rapid and prevents arcing between the disc and brushes. **Norwood Controls,** Norwood, Mass.

Circle 431 on Page 17



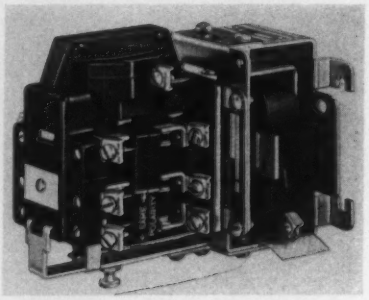
Heat Exchanger Motor

Item 432

Applicable for indoor or unprotected outdoor service in the oil, chemical, paper, rubber, and steel industries and for machine tool and materials handling operations, heat exchanger motor offers a wide adjustable speed range from 5 per cent of the base motor speed by armature control (constant torque) to 400 per cent of the base speed by field control (constant horsepower). This speed is made possible by use of an integrally mounted ac fan motor to supply a constant flow of cooling air regardless of the speed of the dc motor.

Motor is constructed in an explosion-proof enclosure for hazardous installations, is protected against dirt, coolants, moisture, oil vapors, and other atmospheric conditions. Heavy rolled steel field ring and cast steel bearing brackets are used to equip the motor for rigorous industrial service. The motor can be mounted horizontally on the floor, wall, or ceiling, or vertically with the shaft up or down. **Louis Allis Co.,** Dept. P, 427 E. Stewart St., Milwaukee 1, Wis.

Circle 432 on Page 17



Control Relay

Item 433

Line of mechanically held control relays is rated at 10 amp, 600 v. Device consists of a standard electrically held relay and an attachment. There is no increase in panel area required for this relay, and wiring methods do not have to be changed on panels which incorporate both types of devices. Both the relay pick-up and attachment drop-out coils are of molded construction for maintenance free life and are designed to have a resistance to mechanical damage and low rate of moisture absorption. There are eleven different types of units with up to ten contacts. **Square D Co.,** 4041 N. Richards St., Milwaukee 12, Wis.

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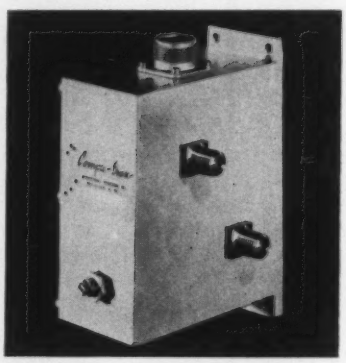


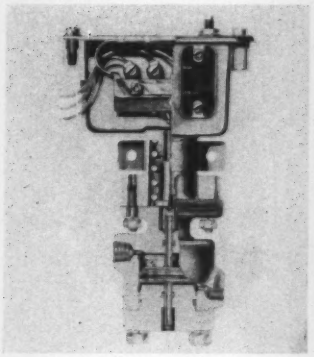
Pressure Transmitter

Item 434

Unit is suitable for corrosive atmospheres; is available in static pressure ranges from zero to 100 to zero to 3000 psi, with differentials up to 100 per cent of range. Model 70-2900 features infinite resolution and zero output which can be preset at any point throughout the range. Sensing element of the unit is a differential transformer with

a built-in demodulator for dc outputs. The inputs available are 6.3 v or 110 v ac; full scale outputs available are 50 mv dc or 5 v ac or dc. **Computer Components Div., International Resistance Co.**, 401 N. Broad St., Philadelphia 8, Pa.

Circle 434 on Page 17

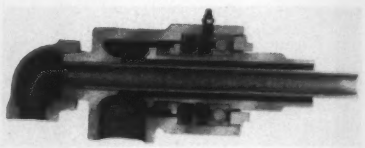


Pressure Switch

Item 435

Designed to sense a difference between two pressures (from 5 psi to 140 psi), switch is particularly suitable for filter installation. When a filter becomes clogged, the switch senses the pressure difference across the filter's inlet and outlet and actuates a warning circuit. A sealed piston sensing element actuates an electric circuit upon reaching a predetermined pressure difference. The unit is applicable to oil systems ranging from 50 psi to 6000 psi working pressure. A high proof pressure rating of 9000 psi gives protection against damage from sudden surges and shock loads. Fixed actuation value of the switch is from 5 psi to 15 psi, depending on the working range of the system. **Barksdale Valves**, 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle 435 on Page 17

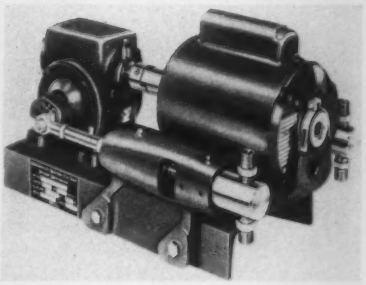


Revolving Connection

Item 436

Device is a revolving sealing connection placed between a stationary supply pipe and a revolving machine cylinder, roll, or drum. It can handle steam, water, air, vacuum, industrial fluids, and gases on applications up to 250 psi, 150 psi steam, and temperatures to 500 F without any adjustments. Unit features a mechanical seal designed to automatically increase or decrease pressure in proportion to the fluid pressure of the application. Sealing is accomplished by two parallel optically flat lapped surfaces running together in an opposite plane in relation to the axis of the shaft. Connection is furnished in two styles—Type P is for single applications and Type S has a dual pipe connection for siphon duty on installations where both supply and return of gases or liquids are required within the same unit or for siphon drainage of condensate from steam chamber or drum. Pipe sizes range from $\frac{1}{4}$-inch through 3 inches, with right or left hand threads. **Perfecting Service Co.**, 332 Atando Ave., Charlotte 6, N. C.

Circle 436 on Page 17

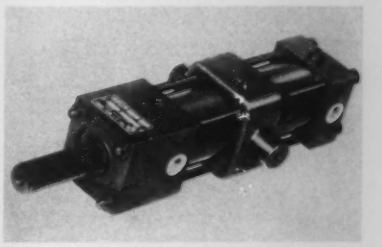


Proportioning Pump

Item 437

Unit is capable of handling capacities ranging from 0.65 gph to a maximum of 13.10 gph at a maximum pressure of 1000 psi. The pump is suitable for use in the petrochemicals, chemicals, and water treatment industries. Stroke length is adjustable from zero to a maximum of $1\frac{1}{2}$ inches. A screw adjustment on the crank adjusts the stroke while the pump is stopped. Repetitive metering accuracy within a tolerance of ± 1 per cent is obtained when the pump operates between the limits of 10 to 100 per cent of stroke length. Ball-check column type valves with replaceable seats provide minimum restriction in flow. These valves allow for the minimum requirement in net positive suction head. Pump is equipped with an electric motor that is open, dripproof, single phase, 60 cycle, 115 v. **Pump Div., American Meter Co.**, 13500 Philmont Ave., Philadelphia 16, Pa.

Circle 437 on Page 17

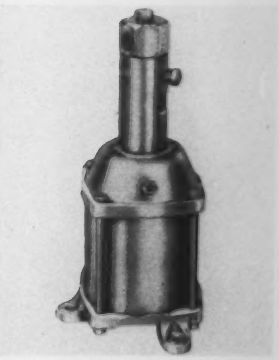


Trunnion Cylinder

Item 438

Line of adjustable-trunnion cylinders has pressure ratings of 200 psi (air) and 1000 psi (hydraulic). The one-piece trunnion is supported and positioned by four threaded cylinder tie-rods. This design aids adjustment since the trunnion is shifted by loosening the tie-rod self-locking nuts to permit rotation of the rods by their solid hex ends. The rotation provides precise movement of the trunnion to the desired location. Other features of the cylinder include: Steel end plates, alloy steel piston rods, and large flow area of ports for fast cylinder operation. Unit is available in nine bore sizes ranging from $1\frac{1}{2}$ to 8 inches, with four cushion styles. **S-P Mfg. Corp.**, 30201 Aurora Rd., Solon, Ohio.

Circle 438 on Page 17



Air-Hydraulic Booster

Item 439

Vertical-type booster can convert the instant action of air into the force of hydraulic pressure. The

THE MARK OF QUALITY

BARBER COLMAN

Wheelco Instruments

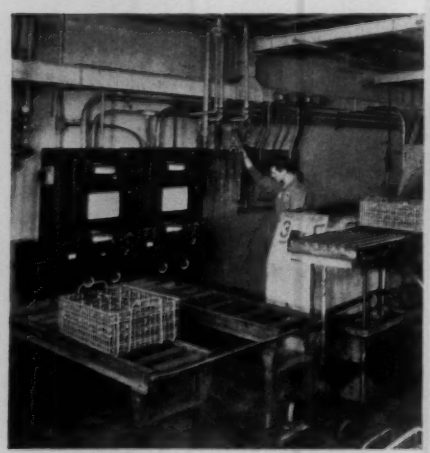
Now, Wheelco the leader offers 3-function control forms with low-cost 400 Series controllers

Proportioning with automatic rate and reset makes Wheelco stepless, electric proportioning control better than ever.

Outstanding accuracy and unmatched economy have been combined in Series 407 millivoltmeter controllers by the undisputed leader in supplying stepless electric proportioning control. Instrument users benefit from advanced designs backed by thousands of successful installations. Wheelco not only gives you 3-function controllers, but for stepless electric proportioning control your systems can incorporate:

1. **CURRENT LIMITERS** for added protection on molybdenum-wound or platinum resistance elements.
2. **ANTICIPATORY ACTION** to give fast warm-up without temperature overshoot.
3. **NEW PILOT AMPLIFIERS** with more efficient components and biasing circuitry for improved linearity.

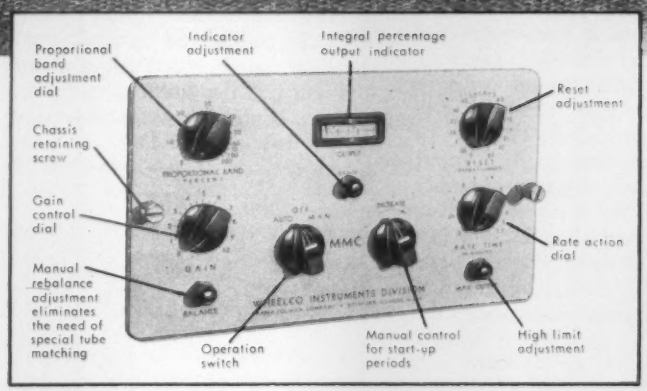
Let your nearby Wheelco engineer help in the solution of your control problems. He is as close as your telephone. You can expect more when you specify Wheelco and be sure you get it.



Heat-treat department uses 12 saturable reactors to handle various types of furnaces, gets better work quality, lower power costs.

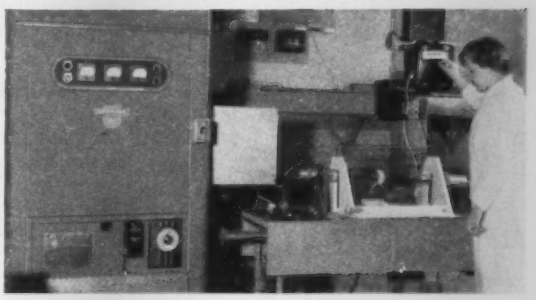
Ease of replacement of components proves of added value on battery of creep test furnaces as chassis can be replaced even during test.

Transistor cells are assembled on tinned tabs and go through this 12-zone furnace where temperature control must be ultra-precise.



The 3-function controller for automatic rate, reset and proportioning action on a millivoltmeter-type controller is a Wheelco exclusive. It provides outstanding process control accuracy at minimum cost.

Harsh thermal shocks must be avoided in this induction heating setup for growth of germanium semi-conductor crystals. Growth is in Vycor tube with heating coil on outside and carbon ring holding thermo-couple inside.



BARBER-COLMAN COMPANY

Dept. N, 15108 Rock Street, Rockford, Illinois, U.S.A.

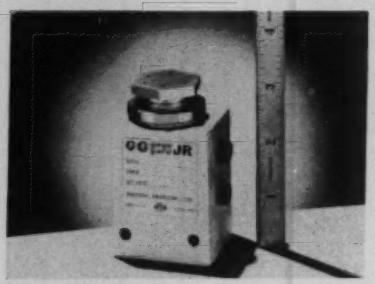
BARBER-COLMAN of CANADA, Ltd., Dept. M, Toronto — EXPORT AGENT – AD. AURIEMA, INC., NEW YORK

Industrial Instruments • Automatic Controls • Air Distribution Products • Aircraft Controls • Small Motors
Overdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

Circle 688 on Page 17

unit includes an air filter made up of tiny particles of solid bronze pressed together to make a fine mesh. This filter is threaded into the breather hole of the air chamber. The chambers are made of honed seamless steel tubing. Hardened steel tie-rods are used to connect the air chamber and hydraulic chamber. **Wilton Tool Mfg. Co. Inc.**, 9525 Irving Park Rd., Schiller Park, Ill.

Circle 439 on Page 17

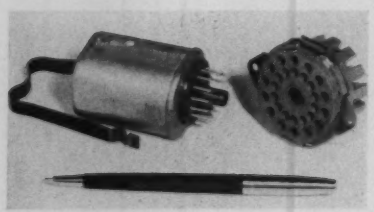


Pressure Cutoff Device

Item 440

Unit is designed to protect sensitive pressure instruments such as incline manometers, draft gages, electrical pressure switches, and ultrasensitive low - pressure transducers. The device, designated Gage Gard Jr., is repeatable and will reopen after sealing at 2 per cent below the cutoff point. Adjustments and the resetting of cutoff pressure points can be made at any time. Device is available in four ranges, covering a span of −15 psig to +85 psig. **Industrial Engineering Corp.**, 525 E. Woodbine, Louisville, Ky.

Circle 440 on Page 17

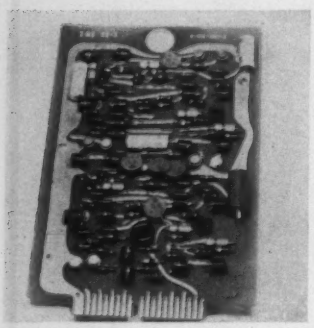


Miniature Relay

Item 441

Miniature sealed electromagnetic relay is adaptable on machine tool controls, welding controls, instruments, and electronic equipment. Feature of the relay is a 14-terminal header with keyed guide post which mates with a heavy-duty, mica-filled phenolic socket to facilitate wire checking and replacement. With the header, minimum creepage is ¼-inch. Unit is a four-pole, double-throw type, designed for 100 million operations at reduced contact loads. It is available in ratings up to 5 amps at 28 v dc or 120 v ac. Operating time with normal voltage applied to the coil is 25 milliseconds maximum, and the release time is 5 milliseconds maximum. **General Electric Co.**, Schenectady 5, N. Y.

Circle 441 on Page 17

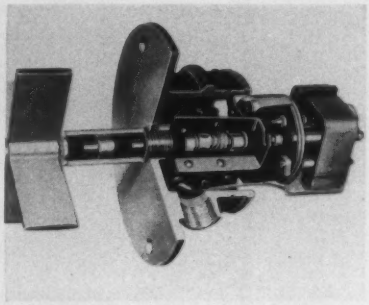


Shift-Register

Item 442

Suitable for use in shifting and storing binary information in computers, data processors, instrumentation, and control systems; transistor shift register is capable of operation up to 2 megacycles per second. Model SR-4-2M (shown) has four register stages with a shift-input amplifier. Another style available—Model SR-10-2M—has 10 register stages and a shift-input amplifier. Each register assembly is mounted on a printed-wiring epoxy-glass plug-in board. The last output of a register assembly can be connected directly to the first input of another, permitting the assembly of registers of any length. The output levels are clamped and can drive heavy external loads. The required shift signal is a 2 v, 0.1 microsecond pulse. Unit is capable of maintaining full operating performance over an ambient temperature range of −55 to 65 C. **Di/An Controls Inc.**, 40 Leon St., Boston, Mass.

Circle 442 on Page 17



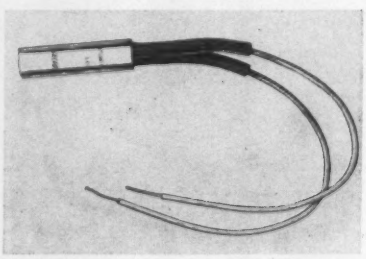
Bin Level Indicator

Item 443

Control for bulk bins features a safety device which stops and starts accessory equipment. A limit switch acts as the safety device. It is activated 18 times a minute and can be connected for visible or audible control. If any part of the indicator fails in its operation, the signal is altered and other equipment controlled by the indicator is either stopped or started.

In operation, a 1/100 hp motor turns a four blade paddle at 9 rpm by means of a torsion spring. The paddle turns continuously as long as there is no material touching it. When the material makes contact with the paddle, the paddle stops. The motor continues to run, turning the spring until it activates the limit switch (which is the safety device). The switch kicks off the motor and any other equipment connected to the indicator. When the material falls away from the paddle, the torsion spring reactivates the paddle and unwinds from the limit switch, starting the motor and putting the unit in operation again. **Convair**, 1059 Bayridge Ave., Pittsburgh 26, Pa.

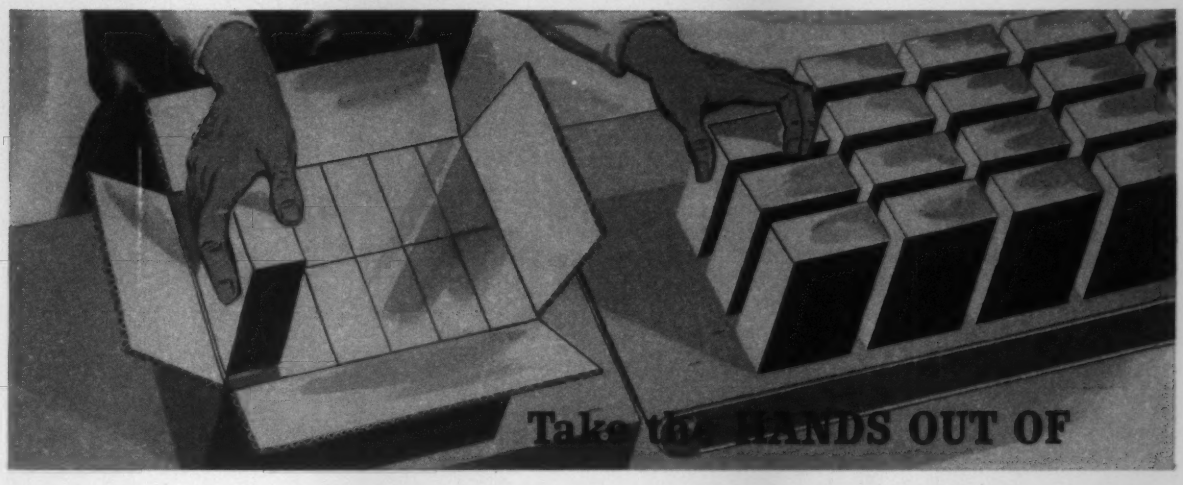
Circle 443 on Page 17



Cartridge Heating Unit

Item 444

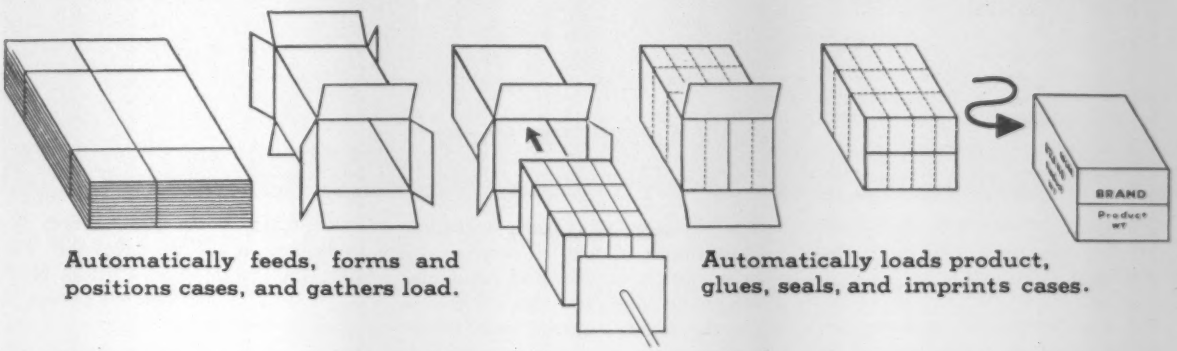
Unit, designated Firerod, is available in ⅝-inch diameter, with



Product Handling

let Packomatic® equipment do any or all your casing operations AUTOMATICALLY:

T.M. Reg. U. S. Pat. Off.



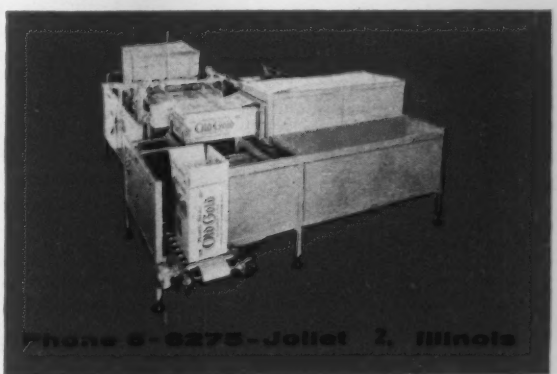
Automatically feeds, forms and positions cases, and gathers load.

Automatically loads product, glues, seals, and imprints cases.

For casing round, square, rectangular, or free-form packages of virtually any size.

If you employ even one person per shift to hand-form cases, or to hand-pack, hand-seal or hand-imprint them, then it can pay you to install Packomatic equipment. And if you employ two or more people the savings can increase proportionately. Even a **complete** automated Packomatic line requires only a minute or two of attention at infrequent intervals to match the output of a dozen pair of hands. And in addition to reducing your direct labor production costs Packomatic can, by utilizing end-opening shipping cases, reduce paper-board costs up to 25%. And mechanically end loaded cases are stronger too, because the flaps give added resistance to weight and shock. In addition, they stack better because their uniformly flat sides enables keying of pallet loads. Write, wire or phone us for facts on how to reduce your casing costs.

FOR EXAMPLE: This Packomatic machine at the P. Lorillard Co. automatically forms and positions cases, end-loads regular or king-size cartons of Old Gold cigarettes (60 cartons per case) and up-ends cases for sealing — at the rate of 400 cartons per minute, or nearly 5 million smokes per hour.



PACKOMATICS include Case Sealers • Case Opener-Loaders • Case Packer-Gluers • Case Imprinters • Bale Sealers • Automatic Equipment for Shelf Carton Making, Feeding, Filling and Closing • Round Paper Can Mfg. Equipment

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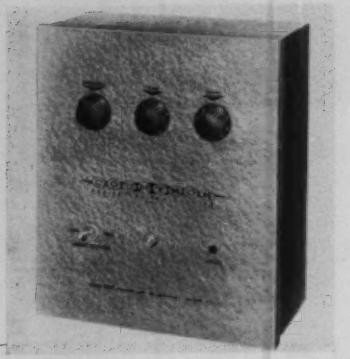
Circle 689 on Page 17

standard length ranging from 1 to 12 inches. Device is designed for use at maximum wattages of 1850 and 2500 for 115 v; 3700 and 4700 for 230 v; and 450 and 575 for 28 v, with amperage ratings up to 20.6 amp. It is said to produce up to 5 times more heat than previous units. **Watlow Electric Mfg. Co.**, 1376 Ferguson Ave., St. Louis 14, Mo.

Circle 444 on Page 17

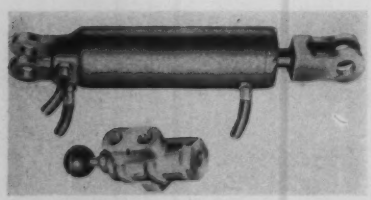


Predetermined Counter

Item 445

Instrument can handle counting and batching speeds at a rate of up to 1000 impulses per minute. It is designed to operate under the conditions of vibration, shock, heat, cold, dust, and humidity. Counter features automatic and instantaneous recycling to zero after each completed count cycle. It can be mounted on a machine or on the wall, and is available in three models providing a predetermined selectivity range of from 1 to 10,000 counts. **Hobson Miller Machinery Corp.**, 280 Lafayette St., New York 12, N. Y.

Circle 445 on Page 17

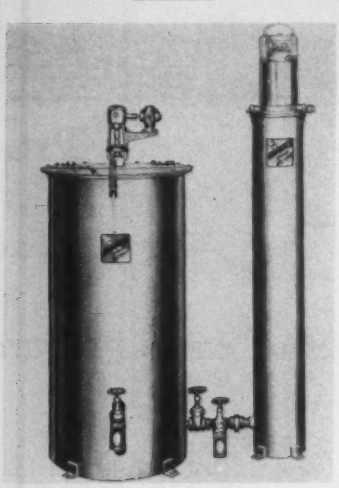


Multistroke Cylinder

Item 446

Unit, designated Hydro-Stop, can be used with any existing 3 or 4-way hydraulic system. It features a floating piston within the cylinder which is controlled by a special valve. The floating piston is hydraulically positioned and set at any desired stroke length. It will continue to repeat this stroke until the position of the floating piston is changed by the operator (this is done remotely). The unit is available in maximum bores and strokes to suit specific requirements. **Densmore Engineering Co. Inc.**, 2003 E. 14th St., Oakland 4, Calif.

Circle 446 on Page 17



Paint Circulating Pump

Item 447

Unit is capable of delivering a steady flow of paint while operating at minimum speeds. Pump works on an automatic demand principle. When demand on the system is low the pumps operate more slowly, but when more spray guns are opened, the pumps speed up immediately to supply more material. Air consumption is 2 cfm per gallon at a delivery pressure of 80 psi. Unit is constructed with the air motor and pump section completely separated to forestall the possibility of paint entering the motor and causing damage. Model 32 (at the right in the illustration, mounted alongside a 60-gallon air-agitated circulating tank) is designed to deliver 32 ounces of paint with each stroke or one gallon every two cycles. It will supply paint through more than a mile of circulating line, supplying paint to as many as 55 spray painting stations. **Binks Mfg. Co.**, 3122 Carroll Ave., Chicago, Ill.

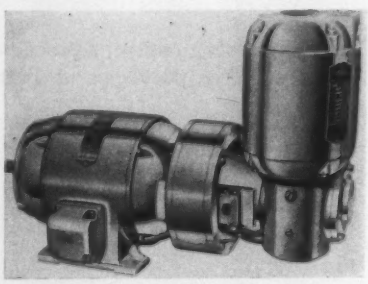
Circle 447 on Page 17

Servo Amplifier

Item 448

Transistorized servo amplifier can operate from a 115 v, 60 cycle power supply. Unit is equipped with an internal dc power supply, does not require a load tuning capacitor. Power supplied to the load is in pulse form of constant amplitude and width, or time duration of the pulse is proportional to the amplitude of the input signal. Phase of the input signal determines the direction of a servomotor's shaft rotation. Effective gain is established at any value between 80 and 1600 through insertion of an external resistor of proper value to achieve the gain desired. While the amplifier is designed to drive 60 cycle servomotors, it can also be modified to drive 400 cycle servomotors which have a maximum power input requirement of 16 w. **Kearfott Co. Inc.**, 1500 Main Ave., Clifton, N. J.

Circle 448 on Page 17



Two-Motor Drive

Item 449

Unit is designed for applications where operating cycles vary from delicate, precise movement to fast operation speeds. It consists of a primary motor and a motor reducer connected by a dc clutch and using a common drive shaft. The primary motor provides the high-

1. Bronze Bearing, with self-adjusting "U" Cup Piston Rod Seal for longer wear.
2. Rod Wiper protects Piston Rod Seal and keeps Cylinder clean.
3. "U" Cup Seals expand with pressure to provide positive seal with minimum friction.
4. Wrench Flats make for easy installation.
5. Ground, hard chrome-plated Piston Rods have minimum yield strength of 125,000 psi.
6. Self-locking cushion adjusting screw and ball check are below surface for protection . . . easily accessible.
7. For extra strength, Cylinder Ends and Mounting Plates are machined from bar stock and steel forgings.
8. Cylinder is precision-finished brass for extra heavy duty.
9. Variety of mountings can be interchanged—easily match any installation requirement.
10. Interchangeable with all JIC Cylinders.

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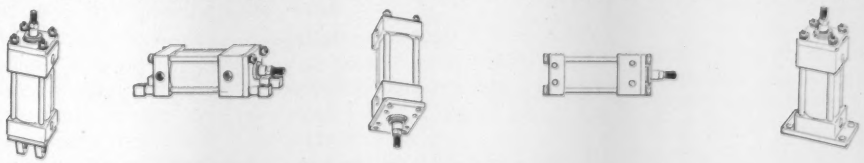

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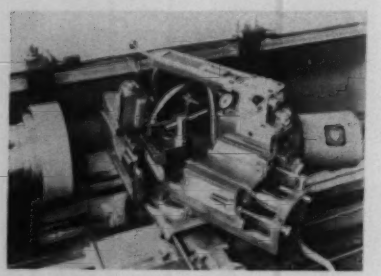
QUALITY AIR CONTROL PRODUCTS

Circle 690 on Page 17

speed output; the reducer provides the low-speed output.

In the illustration, the drive unit is used on a screw conveyor bag filler. The primary motor turns the screw for high-speed (1800 rpm) filling. After the bag reaches 92 per cent of allotted capacity, a weighing scale and electrical device cuts in the 128 rpm reducer for final filling. Unit, designated Multi-Speed, is furnished in ratings from ½ through 40 hp with speed reduction ratios of as much as 100:1. **Reuland Electric Co.**, Alhambra, Calif.

Circle 449 on Page 17



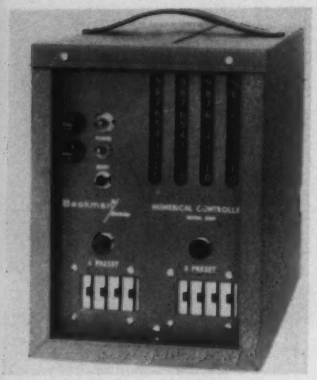
Lathe Tracer Attachment

Item 450

Hydraulically - operated device converts any lathe for automatic multiple-diameter shaft turning and for facing, turning, and boring contoured work. Attachment is made in three sizes to fit lathes up to 27½ inches actual swing and up to 30 hp. It is mounted in place of the standard lathe compound slide and can be swiveled to any desired angle, making it adaptable for internal and external work. Templates or prototype parts are mounted at the back of the lathe on a rail supported by brackets.

In operation, the tracer stylus and the tool approach the cutting position in rapid traverse. Longitudinal feed is engaged, and the tracer stylus automatically controls the cutting tool in a continuous path. The tracer stylus is directly linked to a pilot valve, which maintains an accuracy of 0.001-inch. Unit can also be used as a power feed compound slide for internal or external nontracing cuts or an automatic tracing cycle can be interrupted to modify the shape of a workpiece. **Leland-Gifford Co.**, Worcester, Mass.

Circle 450 on Page 17

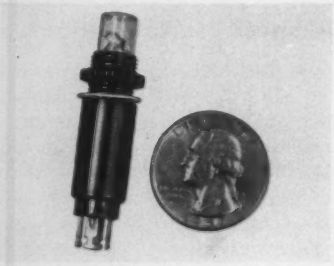


Counter-Controller

Item 451

Miniature magnetic amplifiers are used in line of counter-controllers. Instrument is capable of counting a total of 100,000 events at a maximum rate of 5000 per second. Some of its applications include coilwinding, cutting to length, metal forming, and the testing of physical characteristics. Solid-state transducers supply the input information. Front-panel switches select one or two count totals at which output signals occur. Outputs are relay contact closures rated at 5 amps. **Berkeley Div., Beckman Instruments Inc.**, 2200 Wright Ave., Richmond 3, Calif.

Circle 451 on Page 17

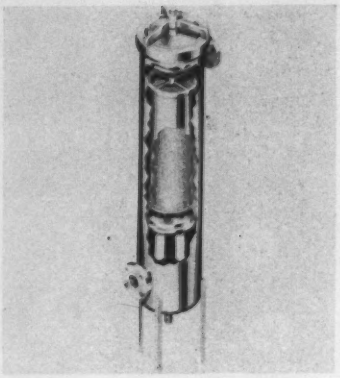


Lighted Switch

Item 452

Miniature lighted pushbutton switch incorporates a neon bulb in the light circuit which is independent of the switch circuit. Switch is a normally open, momentary contact type unit rated at 1 amp, 115 v ac. It is designed to have a minimum life of 500,000 operations. It has a ⅜-32 threaded bushing, 7/16-inch maximum diameter, and less than 1¼-inch behind-the-panel length is required for mounting space. **Grayhill Inc.**, 561 Hillgrove Ave., LaGrange, Ill.

Circle 452 on Page 17



Vapor Adsorption Unit

Item 453

Hydrocarbon vapor adsorption device is designed to protect air and gas systems and pneumatically-operated instruments and mechanisms from the effects of oil vapor, free oil, water-oil emulsions, and dirt. The device operates in two stages. It automatically removes droplets and dirt in one stage. It removes oil vapor and free oil in the form of mist and fog by passing the compressed air or gas through an effective adsorbent. Unit is available in 14 sizes; 11 are for normal pressure applications, 3 are for high pressure applications. **Selas Corp. of America**, Dresher, Pa.

Circle 453 on Page 17

Speed Changer

Item 454

Line of speed changers is available in horizontal and vertical styles, with four-position motor mounting and two-position gear mounting, making it adaptable to varying space conditions. The motor and driver sheave shaft are constructed in one piece and supported between bearings at the ends to reduce shaft deflection. Stepless speed changes are obtained by rotating an external hand wheel which is directly connected to the mechanically adjusted driver sheave. The driven sheave is spring loaded and automatically changes pitch diameter (as the driver sheave is increased in pitch diameter, the driven

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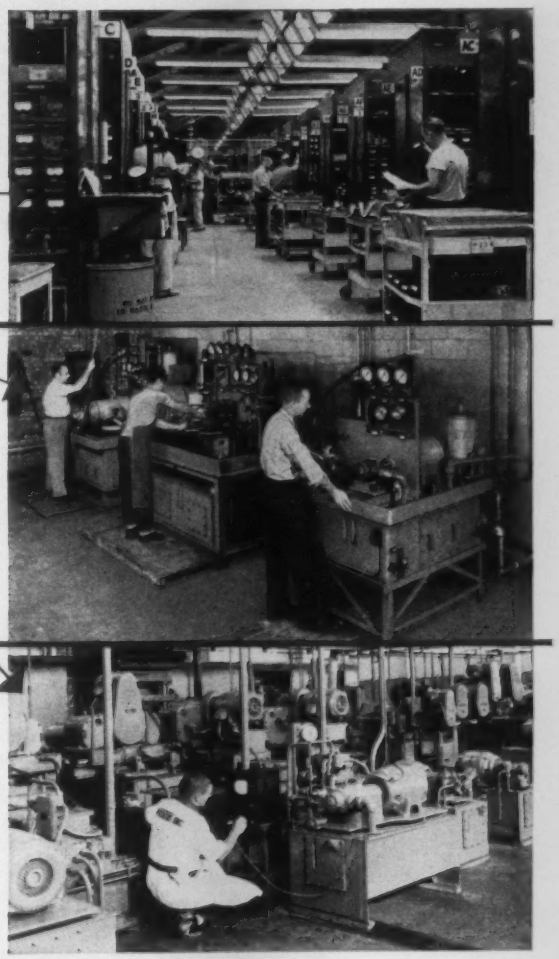

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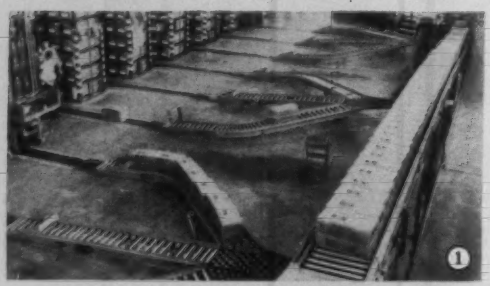

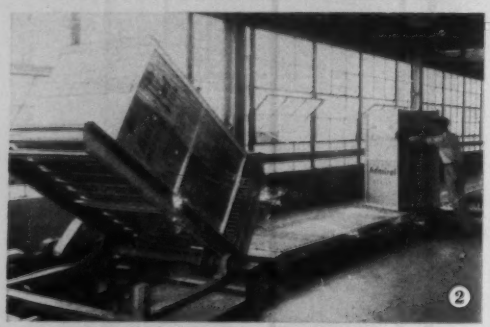

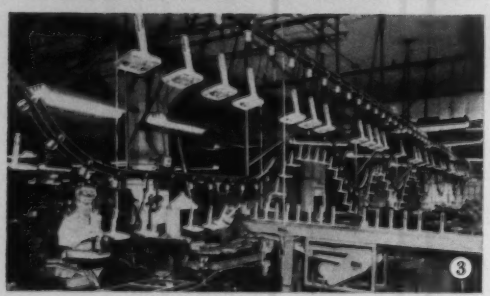

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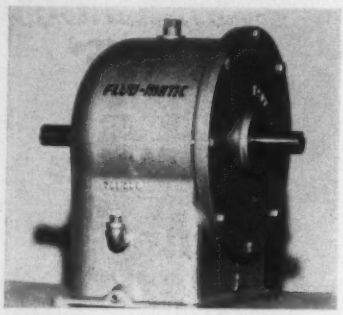
sheave decreases in diameter). Each of the units in the line can be assembled to provide intermediate ratios of 5:1, 4:1, 3:1, and 2:1, using an 1800 or 1200 rpm squirrel cage or *Synduction* motor in open, totally-enclosed, or explosion-proof construction. **Allis-Chalmers Mfg. Co.**, 1126 S. 70th St., Milwaukee 1, Wis.

Circle 454 on Page 17



Torque Converter

Item 455

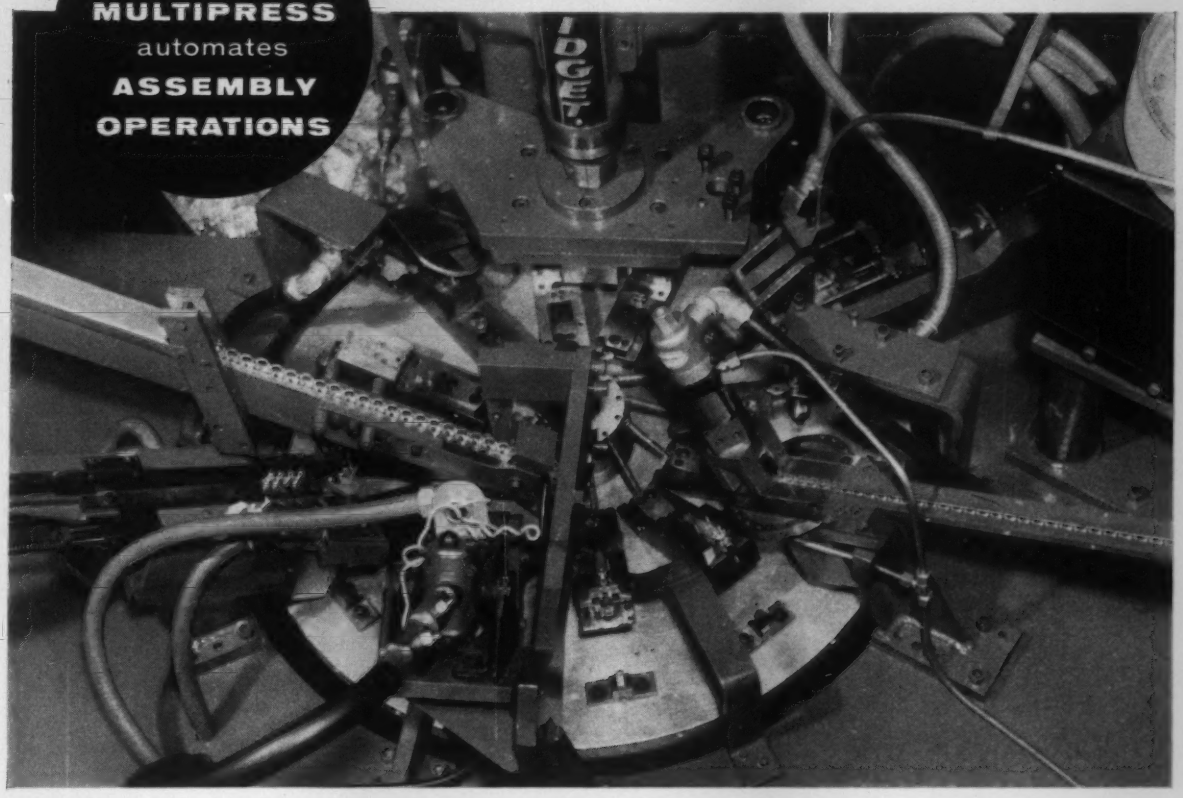
Hydraulic power transmission unit is designed for application to electric motors and gasoline engines in the ½ to 10 hp range and in some instances up to 20 hp. It can be used on conveyors, elevators, grinders, pumps, and drilling equipment. Unit, designated Fluo-Matic, is an infinitely variable speed drive, retaining maximum horsepower output. It permits heavy loads to be started easily, and when accelerated rapidly, it allows electric motors to be matched to the actual running load requirements.

A hydro-kinetic converter isolates the drive and the prime mover. Torsional vibrations originating from the prime mover are not transmitted to the output load and shock loads are not imposed on the prime mover. The prime mover can be started with an output load and will automatically accelerate the load to operating condition without manual clutching or gear changing. The starting load as seen by the prime mover is dependent on the absorption characteristics of the converter. The acceleration is determined by the output characteristics and load-speed relations. **Automation Industries Inc.**, 1121 St. Clair Ave., Cleveland 14, Ohio.

Circle 455 on Page 17

How **DENISON MULTIPRESS** automates **ASSEMBLY OPERATIONS**

45 assemblies-per-minute *are produced on this 1-ton Denison hydraulic Multipress and automatic index table at the Unique Balance Division, S. H. Pomeroy Company, Dubuque, Iowa.*



MULTIPRESS assembles and inspects complex 4-part components

...at a rate of 2700-per-hour

With this Denison hydraulic Multipress and feeding devices, production assembly of complex units has been increased and costs reduced considerably.

Completely automatic, the particular operation shown assembles and inspects the four-part assemblies at a rate of 45-per-minute... *2700-per-hour.* Any defective assemblies are automatically rejected. The operator has only to supervise the equipment and load component hoppers.

The automatic operation shown is typical of how multi-component assembly operations can be simplified with Denison hydraulic Multipress and simple tooling. The Denison field man near you can help analyze your work and demonstrate how you can duplicate these savings in your plant. Write for the Denison catalog describing the full line of Multipress units for your work.

4-part assembly *of spring tension unit for sash balances, used on double-hung windows to replace conventional sash cord and weight.*

DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1234 Dublin Road • Columbus 16, Ohio

Denison Stocking Branch Offices: LOS ANGELES • CHICAGO
DETROIT • ATLANTA • HOUSTON • NEWARK • CLEVELAND

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DENISON HydrOILics

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

Circle 693 on Page 17

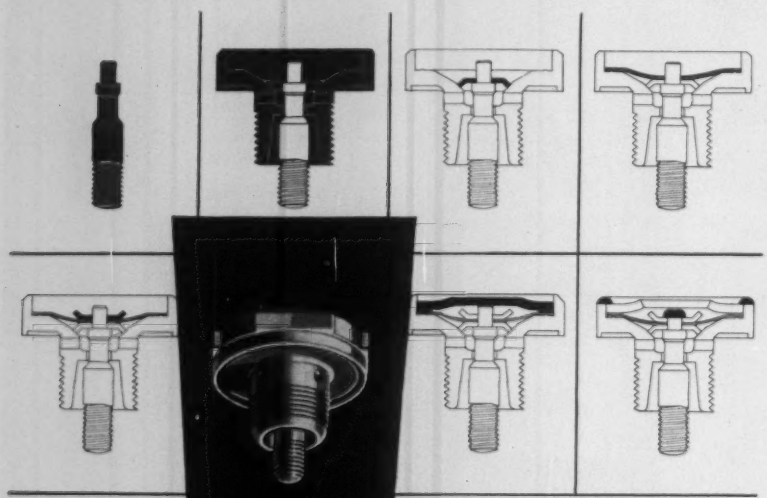
Air-Hydraulic Feed

Item 456

Device combines an air cylinder, a hydraulic control cylinder, and a valve arrangement to provide rapid advance, feed, and skip feed in any combination. It can automate equipment such as milling machines, lathes, drill presses, and packaging machinery. Two movable cams are used to set up any combination of fast, slow, and skip feed strokes. A built-in bypass valve with traveling rods allows rapid advance to any point in the stroke, controlled rate of feed for any distance, pick-up to rapid feed, and return to controlled rate. This cycle can be repeated several times during the stroke by setting the bypass valve cams.

The front portion of the unit is an air cylinder connected to the shop air line. The rear section is a hydraulic control cylinder which works by metering the flow of oil from one side of the piston to the other. A transparent oil reservoir permits a visual check on the oil supply. The hydraulic control section can be set to give control action over any portion of the stroke. Unit is available in 2 and 3-inch bore sizes, with four different stroke lengths. **Electro-Mechano Co.**, 261 E. Erie St., Milwaukee 2, Wis.

Circle 456 on Page 17



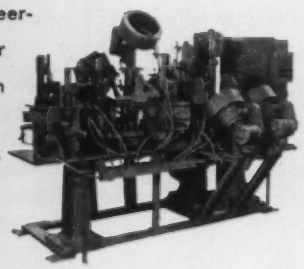
Part: Carburetor economizer diaphragm valve.

Operation: Gaskets and diaphragm cut from reel stock. Seven parts assembled.

Production: 900 valves per hour.

83% labor savings with automated assembly!

Can you automate your assembly operation economically? Gray's engineering staff is best equipped to answer your question. Design, manufacture, installation and initial operation of automated assembly equipment is our only business.



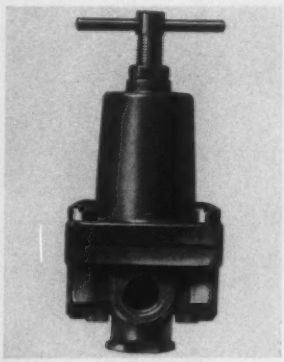
Write for our 24 page bulletin, "Automated Assembly."

SALES TERRITORIES AVAILABLE

gem

GRAY equipment company

13600 Ford Road • Dearborn, Mich. • Telephone: Tiffany 6-7573



Pressure Regulator

Item 457

Compact air pressure regulator is said to have a good flow capacity and accuracy. It is suitable for use with air compressors and paint spray rigs. Unit, designated Series 112, is constructed of diecast zinc, with internal parts of brass, and the diaphragm and disc of oil-resistant Buna-N. The valve is available in ¼-inch size. **Industrial Div., Watts Regulator Co.**, 10 Embankment Rd., Lawrence, Mass.

Circle 457 on Page 17

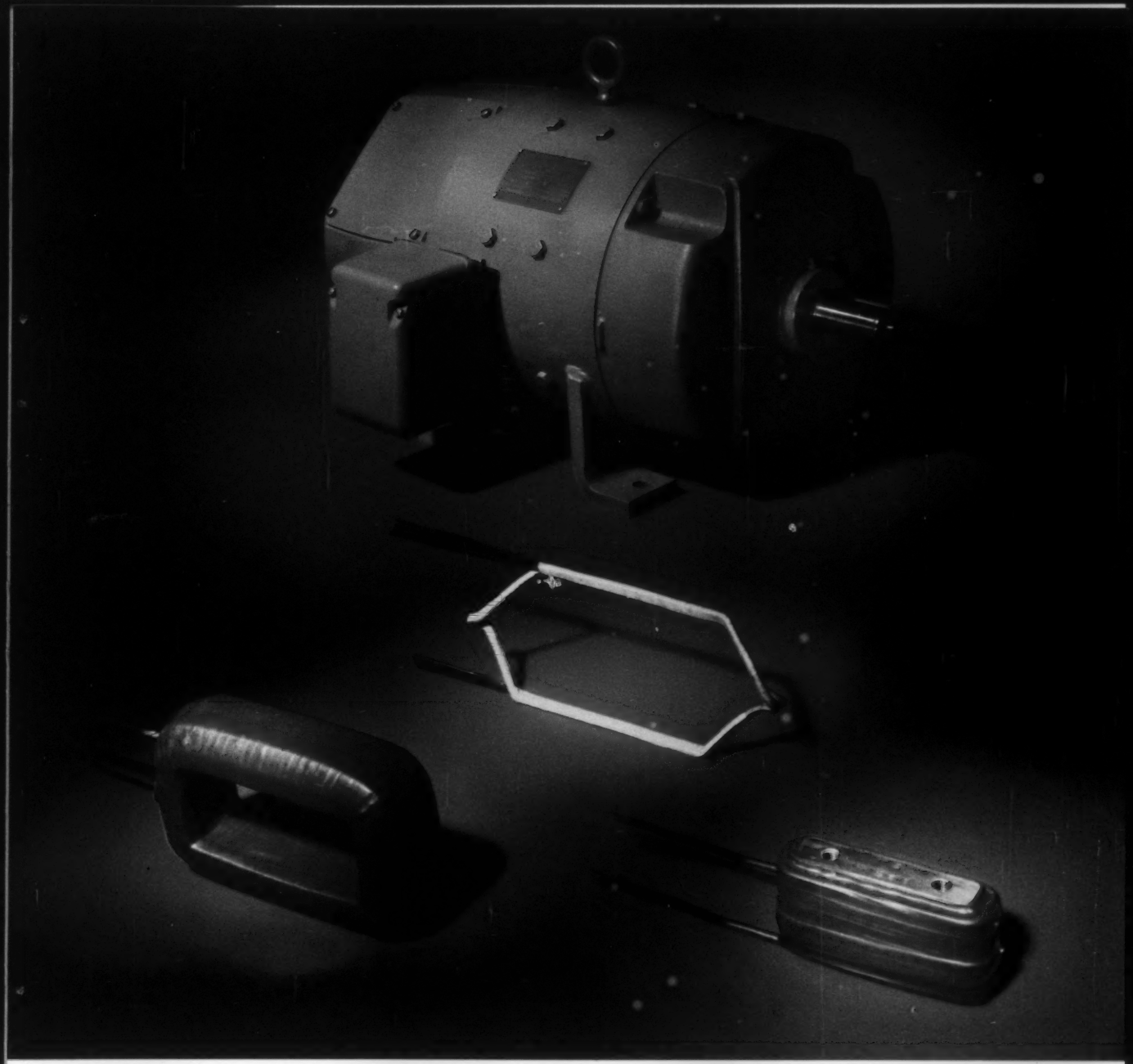
Counter-Controller

Item 458

Adaptable for numerous counting applications, solid state counter-controller incorporating printed

Circle 694 on Page 17

Circle 695 on Page 17→



NEW GENERAL ELECTRIC DC MOTOR HAS

Coils Encapsulated for Longer Life

KINAMATIC* . . . *a new standard in industrial direct-current motors* . . . designed to give extra dependability to automated production systems.

Encapsulated Field Coils . . . insulated with mica and glass and permanently sealed against moisture and corrosive airborne materials . . . virtually eliminates insulation as an element in motor life and adds a reliability factor never before available in a standard direct-current motor.

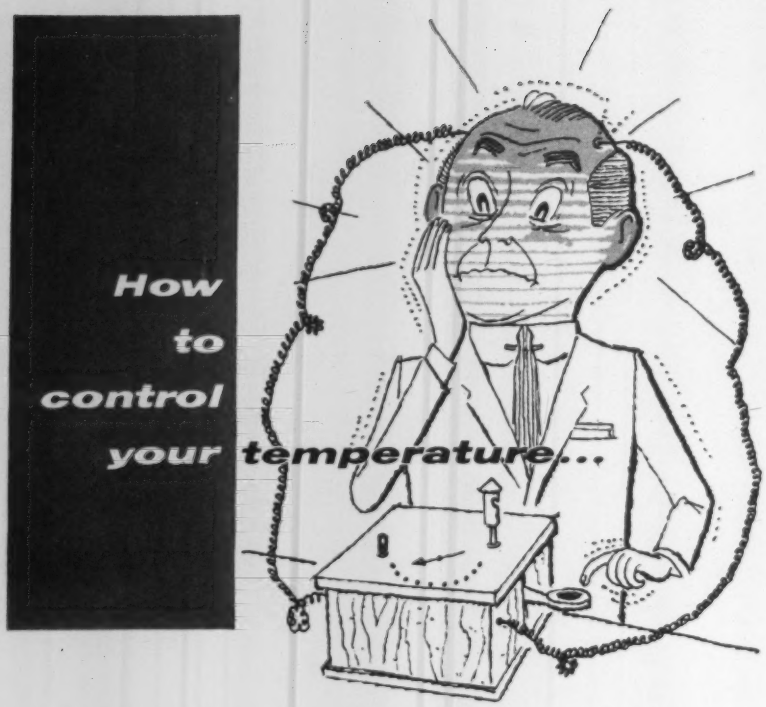
Greater Versatility . . . a 15% service factor now available in the standard, dripproof d-c Kinamatic motor means user can: 1) obtain 15% more than rated power for normal life of motor; 2) obtain 100% longer motor life at rated power; or, 3) obtain greater versatility on speed and horsepower duty cycles.

Additional information is available at your nearest General Electric Apparatus Sales Office. Or, write for Bulletin GEA-6355. *Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.*

*Trade-Mark of General Electric Company. 813-12

Progress Is Our Most Important Product

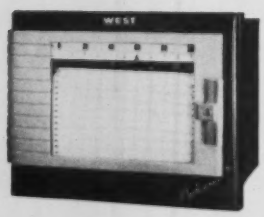
GENERAL ELECTRIC



Your personal temperature may soar when you see the advantages that others gain by improving control of temperature in operations like yours. But you can confidently control both types of temperature by using our consulting service and, if necessary, some of our instruments.

For we are specialists in temperature control. Our world-wide field force is constantly working with situations like yours, seeking waste and hidden potentials where "control is no problem." Working with your own people, chances are they'll find ways to boost your production...assure quality... reduce costs.

We provide such service without charge, to determine whether you really need our indicators or controllers or recorders, thermocouples and accessories. Chances are that you do; for our instruments soon save their cost in avoiding work-stoppage and reducing maintenance.



Marksman Recorders

Model M (shown) potentiometer strip-chart recorder delivers outstanding service and economy through features rarely available in a single instrument. Veri-Tell indicators and Gardsman controllers serve as well. All are tubeless, "solid-state" and proved in wide use. Phone your West consultant (see Yellow pages) or write Chicago office for Bulletin M or for COM digest-catalog of line.

WEST *Instrument* **CORPORATION**
SALES OFFICES IN PRINCIPAL CITIES
FACTORY AND GENERAL OFFICES:
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BRITISH SUBSIDIARY
WEST INSTRUMENT, LTD.
52 Regent St., Brighton 1, Sussex

the trend is to **WEST**

Circle 696 on Page 17

readout is furnished with single or dual preset up to six digits. Presetting is indicated through illuminated number dials. Model BD-1 requires no internal adjustments, will operate under line voltage fluctuations of ±15 per cent from nominal 117 or 220 v ac line. Input signal is between +50 v and −50 v. It will function in temperatures up to 125 F without special cooling. Printer can be set to print totals at periodic intervals, with index number that reads for elapsed time, or to clear upon printing.

When the instrument is used as a time function controller, rpm, flow, or linear speed can be controlled at a single set point. One section of the counter is a variable time base, or can be pulsed from a transducer used to gate the counts from another transducer, so the counter will read directly the values under observation. **Presin Co.**, 12128 W. Pico Blvd., West Los Angeles 64, Calif.

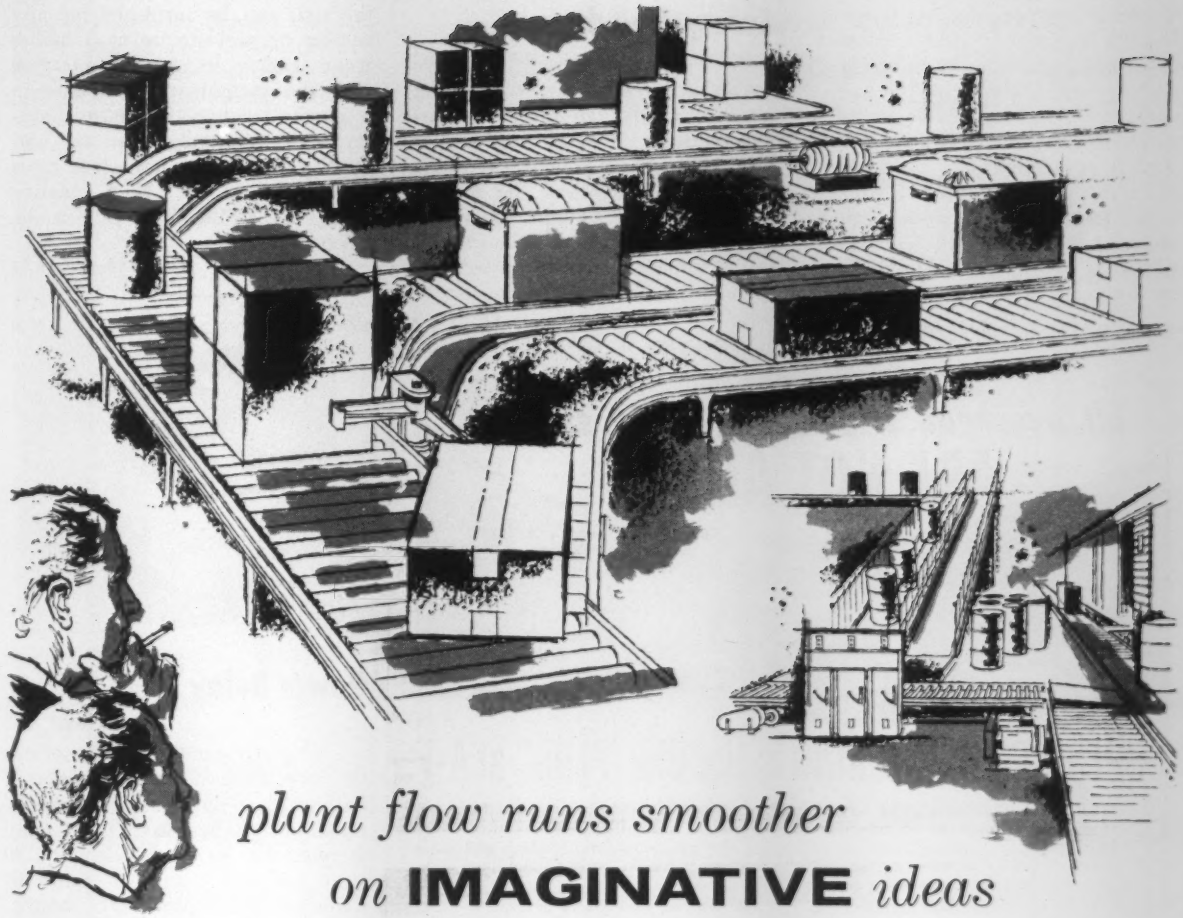
Circle 458 on Page 17

Portable Counter

Item 459

Instrument combines a plug-in electronic decade with a five-digit mechanical register, is suitable for a number of production and process counting needs. Some of the applications include: Total-count measurement and inventory of parts, checking flow of conveyorized parts with a photoelectric cell, and checking production rates on automatic machines and presses.

Model 1000-B is capable of up to 12,000 counts per minute. Counting pulses can be from photoelectric cells, magnetic pickups, or contact closures. Input signals can be



plant flow runs smoother
on **IMAGINATIVE** *ideas*

Imaginative new ideas in modern materials handling can smooth out your plant's work flow. For factories, mills and warehouses across the country, conveyor systems engineered by Alvey speed up output and cut production costs as much as 30 per cent. This unique Alvey approach often pays for itself in just a few months. Unless you have reviewed your package handling methods lately, you may be missing similar savings.

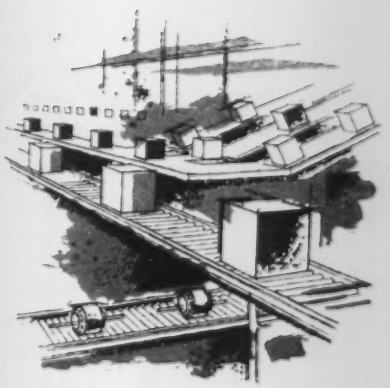
Whether you need a completely integrated, automatic system or individual package handling units, Alvey can put this creative planning to work for *you*.

If you're planning to build, modernize—or if you're simply open to new ideas—call in Alvey. A team of experienced engineers will be happy to help you. No obligation for consultation.

Alvey Conveyor Manufacturing Co.
9373 Olive St. Rd., St. Louis 24, Mo.

Alvey . . . serving these famous names and many more

Quaker Oats Co.	Olin Mathieson Corp.
A. O. Smith Corp.	Armour & Co.
General Motors Corp.	Standard Oil Co.
S.K.F. Industries, Inc.	J. P. Stevens & Co., Inc.
McKesson & Robbins, Inc.	American Airlines, Inc.
Magnolia Petroleum Co.	F. W. Woolworth Co.



ALVEY *moves more for modern industry*

ENGINEERED CONVEYOR SYSTEMS • PALLET LOADERS AND UNLOADERS • VERTICAL LIFT CONVEYORS
ROLLER, BELT, APRON, PUSHER BAR, SPIRAL, AND SLAT CONVEYORS • PACKAGE HANDLING SPECIALTIES

Circle 697 on Page 17

sinusoidal, rectangular, or slow-rising. The counter circuit consists of an input amplifier, pulse sharper, and electronic decade. With an accuracy of ±1 count, the instrument will respond to electrical pulses with a peak amplitude of ±2½ v. Unit can operate from 105 to 125 v ac, contains an accessory power outlet of 90 v dc for photocells. **Performance Measurements Co.**, 15301 W. McNichols, Detroit 35, Mich.

Circle 459 on Page 17

Safety Switch

Item 460

Device is capable of monitoring air flow on the fan suction or discharge ducts of paint finishing or other processing systems. If there is any interruption of the normal flow of air from the fans, the switch will react instantly; in the case of ovens, shutting off gas burners immediately. The switch can also be wired to actuate alarms. Designed for pressures of ¼-inch water gage, the unit can be furnished for any suction or pressure up to 3 inches water gage. It can be mounted near the equipment involved or in a remote location, and is available for either normally open or normally closed action. Switch is rated for 5 amp, 115 v. **R. C. Mahon Co.**, East 8-Mile Rd., Detroit 34, Mich.

Circle 460 on Page 17

all overhead trolley conveying systems

ARE NOT ALIKE!

SUPERIOR ENGINEERING is the BIG "PLUS" at A-F

GETTING THE BIGGEST saving from the installation of an overhead trolley conveying system takes a lot more engineering "know how" than meets the eye.

BUT—because A-F founded the package conveyor industry back in 1901, A-F offers you that *extra* conveying system engineering "know how" that means *extra operational savings!*

For fully automated and semi-automated applications, A-F also *engineers* control centers, positioning devices, automatic loading and discharge units, other ancillary equipment.

Whatever your parts and product handling needs, A-F *engineers* the *right type* of conveying system to cut costs and increase profits in your plant.

Write—without obligation—today!

YOU CAN SEE THE SUPERIORITY OF A-F CONVEYOR ENGINEERING

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A-F *ENGINEERED* CONVEYING SYSTEMS

Also Pre-Engineered Conveyors—Wheel, Trolley, Roller, Belt

Metal Cleaning and Processing Machines

THE ALVEY-FERGUSON CO., 171 Disney St., CINCINNATI 9, O. and Azusa, Calif.

Circle 698 on Page 17

ACRO WELDER MFG. CO.

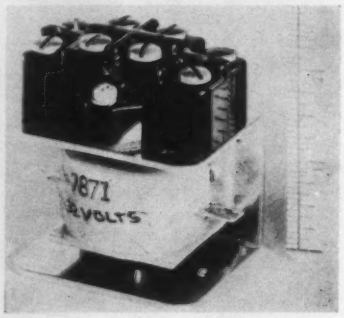
MILWAUKEE

WELDING ENGINEERS

MACHINERY BUILDERS

ESTABLISHED 1936

Circle 699 on Page 17



Power Relay

Item 461

Unit is designed so that either the switch or coil can be replaced without removing the relay from its mounting. The heavy duty relay is rated for 20 amp, 2 hp at 230 v ac. It is less than 3 inches in diameter, 2-1/16 inches in length, and 1½ inches in width. Either side or bottom mounting can be furnished. The multiple circuit arrangements available include: Double pole double throw; single pole double throw; double pole single throw normally closed; and double pole single throw normally open. Coil voltages for ac are: 24, 32, 115, and 230; for dc: 12, 30, and 115. **Acro Div., Robertshaw-Fulton Controls Co.**, 2040 E. Main St., Columbus 16, Ohio.

Circle 461 on Page 17

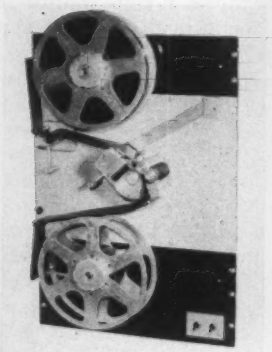
Speed Changer

Item 462

Miniature speed changer can be used in servomechanisms, oscillo-

graphs, and chart drives. Input and output shafts run in heavy-duty ball bearings. Countershafts are self lubricated, run in sintered iron and copper bearings. The spur gears are 96 pitch and 20 degree pressure angle. Ratios from 1:1 to 5:1 handle up to 16 oz-in. of torque; and ratios from 6:1 to 531441:1 handle up to 24 oz-in. measured at the low-speed shaft. Unit can operate at speeds up to 10,000 rpm at the high-speed shaft; maximum power output at the low-speed shaft is 0.025 hp. **Metron Instrument Co.**, 432 Lincoln St., Denver 3, Colo.

Circle 462 on Page 17



Tape Transport

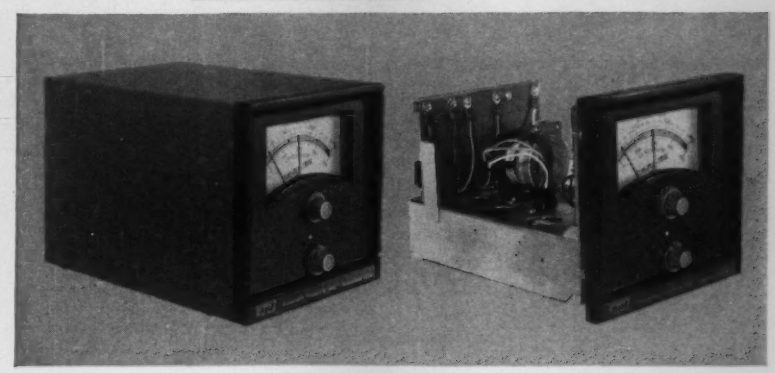
Item 463

Unit is designed to maintain exact synchronization between a recorded and a fixed reference frequency, over wide variations of record speed and line variations. Speed control system is rapid acting and completely damped to permit the exact replay of tapes from uncontrolled recorders. The only requirement is that the recorded tape must have a fixed frequency reference. Transport is available in two styles. Model 460A is a portable unit, can operate from 28 v dc. It will handle ¼ to 1-inch tape and can be furnished with a 2 ms *Start-Stop* time. The unit normally operates at 7.5, 15, 30, and 60 ips, tape synchronous at all speeds. Model 461 is designed for fixed installations, has the same performance as the portable unit, but the *Start-Stop* time is 30 ms and it will accommodate 2-inch tape. **Sangamo Electric Co.**, Springfield, Ill.

Circle 463 on Page 17

NO TEMPERATURE OVERSHOOT

WHEN SIMPLYTROL MINDS THE POT



TIME-PROPORTIONING CONTROL HAS UNIQUE ANTICIPATING ACTION

The new A.P.I. *Simplytrol* brings an extremely high degree of precision to low-cost temperature control. On most applications, this meter-relay-actuated controller will hold temperature accurately to within ±1°F. of a desired set point.

An ingenious anticipating circuit aids in the "pot minding." When the measured temperature approaches the set point, an electrostatic attraction is created between the contacts on the indicating and adjustable pointer-arms. This electrostatic force increases rapidly as the contacts move closer together and causes premature closing of the circuit, thereby avoiding temperature overshoot by early shut-off.

Built around the well-proven A.P.I. meter-relay design, Simplytrol is a complete controller package which uses no amplifying circuits or vacuum tubes: it is perfectly stable, thoroughly reliable. And it costs much less than comparable temperature controls.

Available in thirty ranges from −400°F. to +3000°F., Simplytrol is packaged in an attractive case that converts in minutes from table-top enclosure to panel-mounting rack. Special models offer an adjustable time-proportioning band.

For complete information, request Data Sheet 9-B.

api **ASSEMBLY PRODUCTS, INC.**
Chesterland 27, Ohio

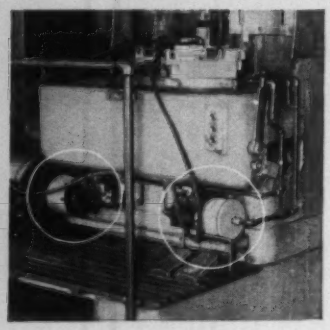
S.A. 1804

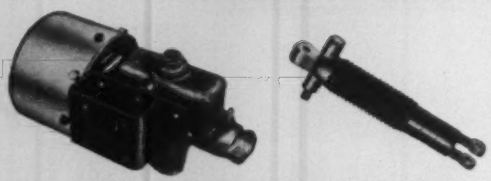
Circle 700 on Page 17

Let Wagner solve
YOUR ACTUATION PROBLEM

Wagner Electric Corporation offers a wide variety of air and hydraulic actuators and controls.

For specific applications, Wagner can furnish engineered kits with actuators, controls, tubing, fittings—everything required for complete installation. Your nearby Wagner field engineer will get you detailed specifications on a system for your particular application. Call him today.

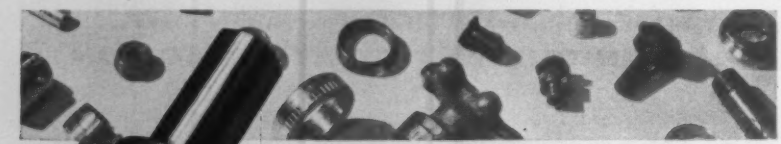


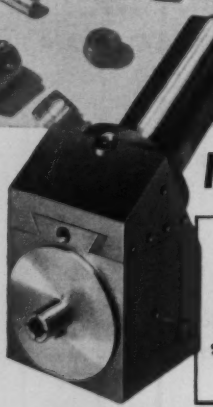


Shown above is a broaching machine with swivel type clamping fixtures, utilizing the Wagner power cluster which converts air pressure to hydraulic pressure that is delivered to actuating cylinders on each of the clamping fixtures.

Wagner Electric Corporation
6430 PLYMOUTH AVE., ST. LOUIS 14, MO. 156-2A

Circle 701 on Page 17





MARK SCREW MACHINE PARTS

NEW METHOD Model 900
SUPER AUTOMATIC ROLL MARKER

Much Better... at Less Cost!

Specially built for all types of radial end-face marking

Other New Method Automatic Marker Models . .

NM Model 700—cut-off marker for custom OD marking

NM Model 600E—for end-face marking

NM Model 500C—for standard OD marking

★ There's a New Method automatic marker for most marking requirements, each designed for a specific need.

★ New Method also manufactures a complete line of manually operated marking devices.

So Many NM Advantages!

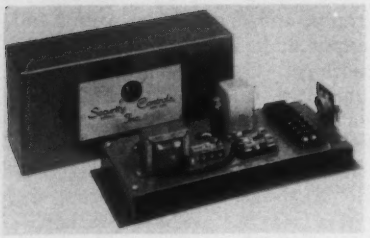
- *Eliminates* secondary end-face marking operations
- *Adjustable* marking depths
- *Contains* an automatic resetting device
- *Stands up* on long production runs
- *Marking Dies* are instantly interchangeable
- *Long* die life
- *Lowers* costs

Write Today for: 900-AC Brochure

NM SINCE 1931

NEW METHOD STEEL STAMPS, INC.
147 JOS. CAMPAU • DETROIT 7, MICHIGAN

Circle 702 on Page 17

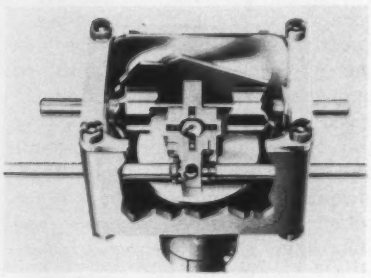


Electronic Limit Switch

Item 464

Model SCI 100 is a transistorized control using minute current to switch, detect, position, and count. Amperage is 50 microamperes at the point of sensing or switching. The control unit amplifies this current to operate a 5 amp control relay. Detection of small, light, metal parts requires only contact with the sensitive point. Several points can be used to check for proper shape or position. When used as a detector, up to 1500 parts can be checked per minute. The sensitive point has no moving parts, needs only contact with a grounded object to complete the circuit. Control operates on 117 v, 60 cycle power, can be placed at a distance from the sensing points and connected to them by a light bell-type wire. **Security Controls Inc.**, 503 Franklin St., Buffalo 2, N. Y.

Circle 464 on Page 17



Linear Integrator

Item 465

Ball-disc linear integrator has many uses. Basic function of device is the integration of a variable with a constant (such as time) to provide a proportionately integrated mechanical output, which is translated into analog or digital signals. In closed loops, the integrator can be used to compute the rate of change of variables, to generate an exponential function, or to square a function. It can also be

Circle 703 on Page 17→

HERE'S WHY SO MANY ENGINEERS SPECIFY P&B's MH RELAY*

*AND VARIATIONS OF THIS BASIC STRUCTURE SHOWN BELOW

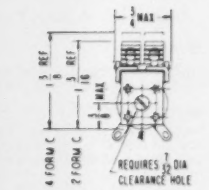
Shown with printed circuit terminals

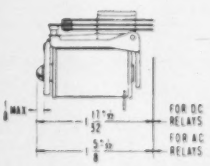
VERSATILITY and adaptability

are prime reasons why designers have made the MH a P&B best seller. This relay series, for example, does yeoman duty in such diverse applications as jet aircraft, street lighting equipment, computers and missile ground controls.

When multiple switching is required...when size, weight, long life and reliability are critical ...our MH relay can usually fill the bill. It's RIGHT for countless jobs, often at countable savings.

Let us send you complete information about this miniature telephone-type relay and the variations we've evolved for special applications. Write or call today.





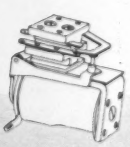
ENGINEERING DATA/MH RELAY

Insulation: Laminated phenolic.
Insulation Resistance: 100 megohms minimum.
Breakdown Voltage: 500 volts RMS between all elements.
Shock: Up to 30g.
Vibration: Up to 10g from 55 to 500 cps.; .065" max. excursions from 10 to 55 cps.
Ambient Temperature: −45°C. to +85°C. −(65°C. to +125°C. on special order).
Weight: 2½ oz. max. (open relay)
Pull-In: Approx. 75% of nominal voltage.
Pull-In Speed: Approx. 15 ms.
Drop-Out Speed: Approx. 10 ms.
Terminals: Pierced solder lugs; special lugs for printed circuits, taper tab (AMP #78).

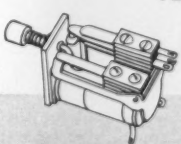
CONTACTS:
Arrangements: Up to 9 springs per stack.
Material: ⅛" silver; also Palladium or gold alloy.
Load: Dry circuits to 5 amps @115V AC resistive.

COILS:
Resistance: 22,000 ohms max.
Power: 100 milliwatts per movable minimum to 4 watts at 25°C. max. (200 mw. min. to meet max. shock/vibration spec.)
Duty: DC: Continuous. AC: Intermittent (2 pole relay max.)
Voltages: DC: Up to 110 volts. AC: Up to 230 v. 60 cycles.
Current: 2.5 ma to 10 amps DC.

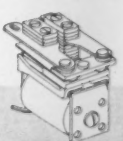
P&B STANDARD RELAYS AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



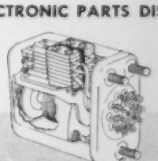
MC FOR RF SWITCHING
For RF switching where intercontact capacitance losses must be minimized. Ceramic contact spacers.



MA LATCHING
Electrical latch; mechanical reset. Small, versatile and offered with selection of contact arrangements.



MB CONTACTOR
Contacts rated 60 amp. 28 volts DC non-inductive. Will carry 150 amp. surge for a duration of 0.3 seconds.



MH SEAL-TEMP
Features sealed coil to minimize contact contamination. Available as hermetically sealed relay only.

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Third Conference on Manufacturing Automation

March 23, 24, and 25, 1959

Purdue University, Lafayette, Ind.

For production executives, manufacturing engineers, and administrative managers who plan, design, and install automated systems for industry.

Topics: Organization and Costs, The Process, Handling in Process, and Control of Operations.

Cosponsored by
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MONDAY . . . . . SESSION I & II . . . . . MARCH 23, 1959

Developing Automation for Flexibility of Output

A PANEL—Manufacturing Engineering—IBM, Endicott, N. Y.
1. ORGANIZATION—**KEITH BENNETT**, Project Engr., Test Equipment Engineering
2. STUDY OF OPERATIONS—**GEORGE PHILLIP**, Project Engr., Mfg. Research
3. DEVELOPING THE HARDWARE—**ALFRED JOHNSON**, Project Engr., Mfg. Research
4. DATA PROCESSING—**WILLIAM ANDRUS**, Manager of Applied Computation
5. ECONOMICS—**RICHARD SEILER**, Technical Ass't to Ass't Mfg. Engr.

Buffet Lunch — **Pioneering in Automation**

WILLIAM ALDEN, President, Automation Management Inc.

Industrial Engineering's Role in Automation of Operations

H. H. YOUNG, Assoc. Prof., Dept of Industrial Engineering, Purdue University

Cost Analysis and Machine Replacement

ROBERT A. LOWE, Managing Partner, R. A. Lowe & Co.

TUESDAY . . . . . SESSION III & IV . . . . . MARCH 24, 1959

Manufacturing Engineering and Machine Procurement

ARMIN FRANK, Manager-Manufacturing, Vacuum Cleaner Dept., General Electric Co.

Assembling Complex Devices

GEORGE WEISER, Chief Process Engineer, Delco-Remy Div., General Motors Corp.

Buffet Lunch — **Automation on the Farm**

E. W. LEHMANN, Prof. Emeritus, Agricultural Engineering, University of Illinois

Handling as the Key to Automation for the Small Company

JAMES R. SEBASTIAN, President, The Rapids-Standard Co. Inc.

Handling Products for Distribution

ALLAN HARVEY, President, Dasol Corp.

Banquet — **Guaranteed Annual Automation**

LEON GREENBERG, Chief, Div. of Productivity, U. S. Dept. of Labor

WEDNESDAY . . . . SESSION V & VI . . . . MARCH 25, 1959

Modern Developments in Control

DR. JOSEPH F. MANILDI, General Manager, Thompson-Ramo-Wooldridge Products Co.

Numerical Control of Production Machines

W. E. BRAINARD, Chief Engineer, Servo Machine Tool Div., Kearney & Trecker Corp.

Buffet Lunch — **Automating the Horses**

O. C. LEVY, Vice President, American Totalisator Co., Div. of Universal Control Inc.

An Institute for Manufacturing Engineers?

Chairman: **R. W. BOLZ**, Editor

• • •

● ***FEE***

Fee for the Third Conference on Manufacturing Automation is $75 which will include the Banquet, the Buffet Luncheons, and a copy of the Transactions.

● ***LODGING***

Rooms are available at the Union Club on the campus at $4 and $6 single, $6 double, and $7 to $9 twin. Room reservations may be made with the Union Club by the form supplied. Accomodations are also available at the Fowler Hotel in Lafayette (city bus to campus) from $3.50. Write direct. For those driving, reservations may be made at the Morris-Bryant Motel, Cedar Crest Motel, or Green Acres Motor Court (2-4 miles north on U. S. 52). For additional information, write K. E. Glancy, Div. of Adult Education, Purdue University, Lafayette, Ind.

Mail to: AUTOMATION CONFERENCE, Comptroller's Office (Conferences), Purdue University.

ROOM RESERVATION

Please reserve in the Union Club the accommodations checked:

Nights: Mar. 22 ☐ Mar. 23 ☐ Mar. 24 ☐

Single Bed—Bath ☐ Twin Beds—Bath ☐

If necessary, will share twin-bed room with another member ☐

Room will be shared by _____

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CONFERENCE REGISTRATION

The following persons plan to attend the AUTOMATION CONFERENCE, March 23, 24, and 25, 1959 (name and title, please):

Name _____

Title _____

Name _____

Title _____

$_____ is enclosed for the registrations checked at $75 each. (Make checks payable to Purdue University.)

☐ Fees will be paid at registration time.

Name _____

Company _____

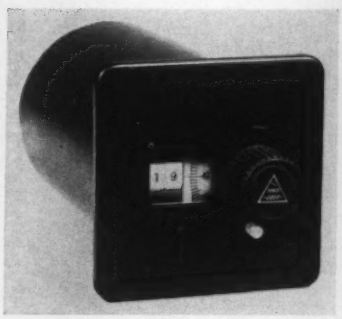
Address _____

Circle 704 on Page 17

used as a variable speed drive, or as a mechanical device to convert linear position to rotary velocity.

Integrator contains three moving elements. A rotating tungsten carbide disc is driven to provide one factor. A pair of precision steel balls is driven by the rotating disc, and a rotating cylinder is driven by the balls to provide integrated output. In operation, as the ball carriage is displaced across the face of the disc, the balls contact various radii of the disc and are rotated at varying rates of speed. The speed of the balls is then transmitted to the output cylinder and shaft proportionally to the product of the disc's velocity and the displacement of the balls. Rotation of the output cylinder and shaft is proportional to the integral of the displacement of the balls along the disc's radius with respect to the variable entered as rotation of the disc. **Librascope Inc.**, 808 Western Ave., Glendale, Calif.

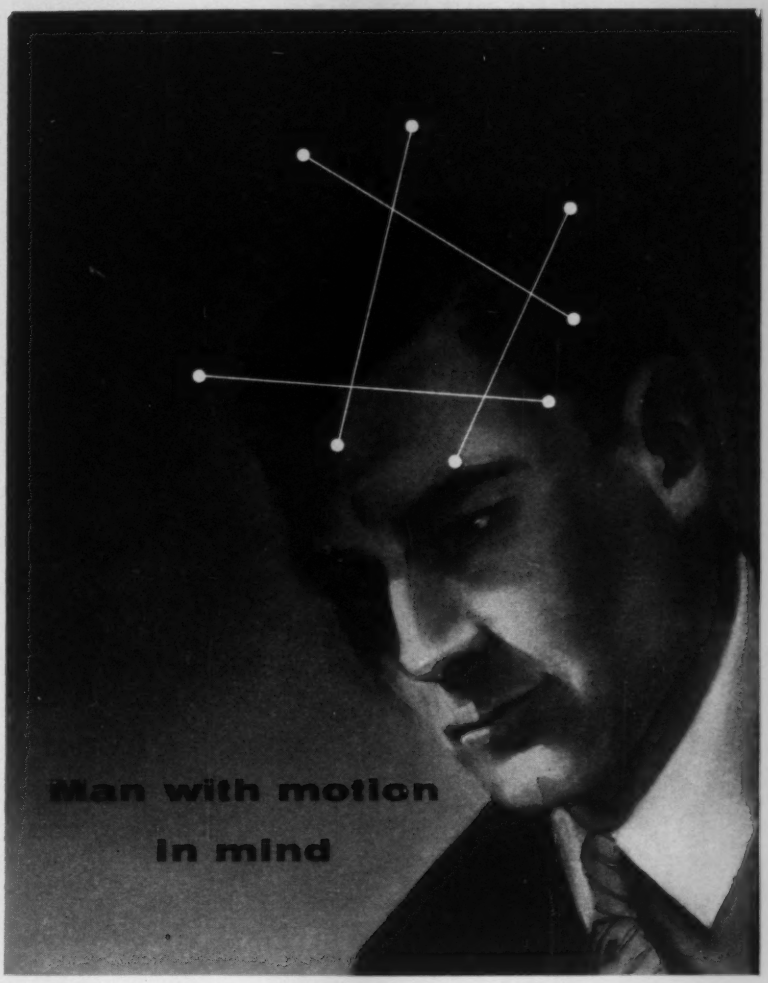
Circle 465 on Page 17



Potentiometer

Item 466

Device can be used in analog computers, comparison standards, meter calibrators, ratio bridges, slide-back voltmeters, precison voltage dividers, or any instrument which requires high resolution. Model 81-A is a three decade voltage divider with a single control knob that operates either of two resistance decades or the interpolating potentiometer. Adjustment is made by pushing or pulling the control knob and rotating it to the desired setting. Three turns of the control knob cover the full range. Unit is furnished in the resistance value of 10,000 ohms; with a resistance accuracy of ±0.05 per cent; linearity ±0.01 per



"The Man from Logan" is challenged by the problem of *motion* every working day. Materials handling encompasses the total aspect of motion; direction, speed, and timing of materials moved over a conveying system. "The Man from Logan" is equipped to diagnose and design the *exact* system to fit the demanding needs of small and large users.

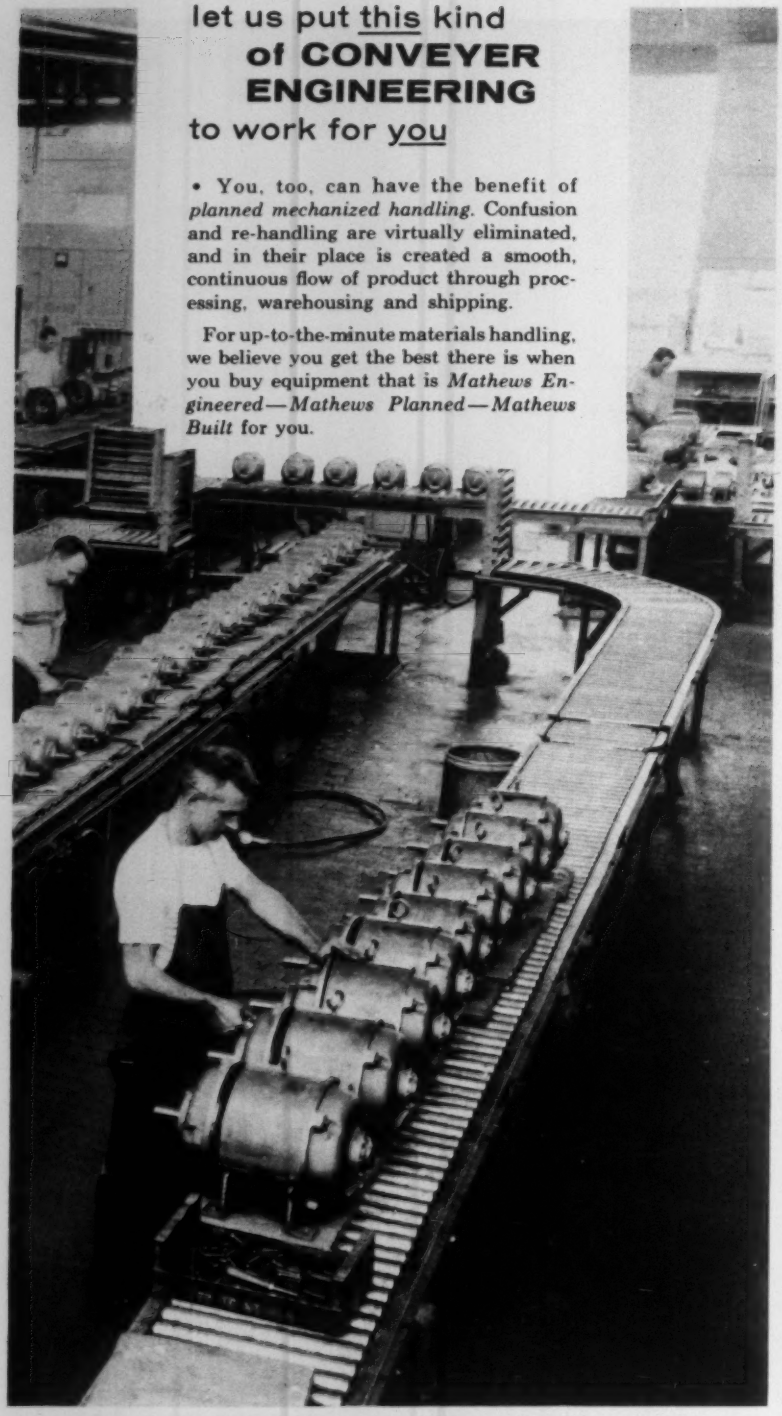
Behind the versatility and training of "The Man from Logan" is the company itself. For two generations the Logan Co. has been a name synonymous with quality, performance and dependability.

If you have a problem in the handling and conveying of your materials, why not talk to "The Man from Logan"? A letter or phone call will bring him to you right away.

Logan Conveyors

LOGAN CO., 218 CABEL ST., LOUISVILLE 6, KY.

Circle 705 on Page 17



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• You, too, can have the benefit of *planned mechanized handling*. Confusion and re-handling are virtually eliminated, and in their place is created a smooth, continuous flow of product through processing, warehousing and shipping.

For up-to-the-minute materials handling, we believe you get the best there is when you buy equipment that is *Mathews Engineered—Mathews Planned—Mathews Built* for you.

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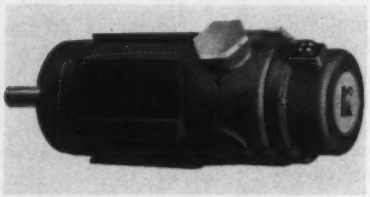
MATHEWS
Over Fifty Years of Leadership in Mechanized Handling

Circle 715 on Page 17

cent; resolution 0.002 per cent or better. The power rating is 5 w; operating frequency range dc to 10 kilocycles. **Rinco Inc.**, 7962 S. E. Powell Blvd., Portland 6, Ore.

Circle 466 on Page 17



DC Control Motor

Item 467

Unit features a permanent magnet field, is constructed to withstand environmental conditions encountered in the processing, chemical, and petroleum industries. Model PC is designed as a building block unit to be incorporated in control equipment. It is available with an integral tachometer generator giving a zero to 5 ma output signal linearly proportional to its speed. Speed is up to 4000 rpm; torque 40 oz-in. **Rotron Controls Corp.**, Woodstock, N. Y.

Circle 467 on Page 17

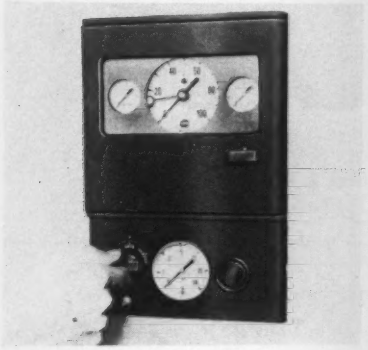
Magnetic Disc Brake

Item 468

Self-adjusting magnetic disc brake is constructed for foot mounting or for *C* flange motor mounting on frames 324UC through 505C. Some of the features of the brake are: Automatic reset manual release, through-shaft construction, high thermal capacity, and heavy-duty discs. The high thermal capacity makes the brake suitable for high inertia loads or high frequency starts and stops. Unit is rated for

125 through 575 lb ft torque. **Dings Brakes Inc.**, 4740 W. Electric Ave., Milwaukee 46, Wis.

Circle 468 on Page 17

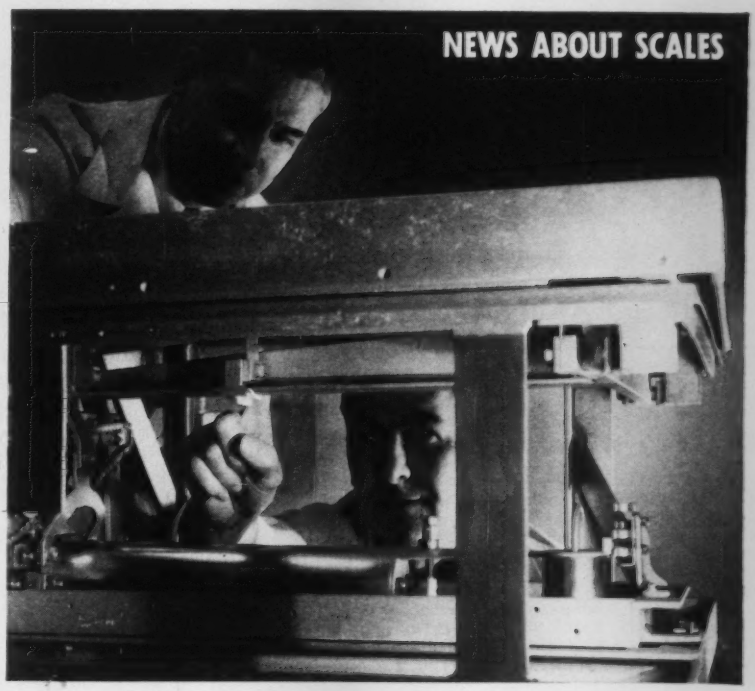


Bypass Control

Item 469

Four-position control bypass is designed for use with company's line of automatic indicating pneumatic controllers. It is mounted directly below the indicating instrument. Basic function of the unit is to give the operator a ready means for cutting off controller air to the valve and for positioning the valve manually. Some of the occasions when the bypass is needed are: On process start-ups where the controlled variable must be carefully raised to the automatic control point; when unusual process upsets require manual rebalancing of a process; or when the controller must be adjusted, serviced, or removed to the repair shop. When the transfer from manual to automatic control is made, the operator can match output air pressures from the controller and manual regulator so there is no difference to upset the process. Unit has three main components—a four-position air transfer switch with *Test*, *Manual*, *Auto*, and *Service* positions; a dial gage for indicating the manually regulated air pressure; and a manual loading air pressure regulator with an adjusting knob on the front of the panel. A pushbutton valve which is on the panel over the transfer switch permits comparison and matching of controller output and manual loading pressures. **U. S. Gauge, Div., American Machine & Metals Inc.**, Sellersville, Pa.

Circle 469 on Page 17



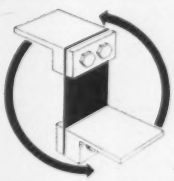
How do they build unvarying accuracy into this remarkable new kind of weighing instrument?

For 7,000 years men have employed the multi-part pivot balance to compare weights. As the parts of their pivot joints wore, the problem of retaining accuracy became more and more acute. Then in 1956 the United States issued a patent for a "Thayer Flexure Plate" Leverage System. A team of engineers and businessmen, aware of industrys great cumulative loss of materials in weighing operations, had devised a revolutionary new scale. Knife-edge pivots that progressively wear and change were replaced by Thayer Flexure Plates that move only .001", yet accurately reflect the minutest changes in weight. This *firmly joined* lever withstands shocks and vibrations indefinitely. Dirt and dust are no longer a problem.

Thayer guarantees this leverage system accurate for the life of the scale.

How Can It Save You Money Year After Year?

Working in conjunction with straight electrical controls, it forms the most reliable, low maintenance system ever devised to control processing or materials handling *by weight*. Literature on its application to filling, batching and checkweighing operations is available on request.



THAYER SCALE

AUTOWEIGHTION SYSTEMS FOR FILLING, BATCHING AND CHECKWEIGHING

THAYER SCALE CORP. • 5 THAYER PARK, PEMBROKE, MASS.

Circle 708 on Page 17

catalogs and literature

Latest automation information. For copies use card page 17.

Belt Conveyor Idlers

Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.—40 *page catalog*—Data are given in Book 2716 on 23 types of belt conveyor idlers for belt widths of 14 inches up to 84 inches. The types of units range from an idler for intermittent operation with relatively low capacities to an idler for continuous operation and high capacities. Lubricating instructions are also given. Also included are illustrations of belt conveyor components such as trippers, pulleys, drives, and backstops.

Circle 470 on Page 17

Pneumatic Comparator Gages

Moore Products Co., H & Lycoming Sts., Philadelphia 24, Pa.—20 *page booklet*—Air gages for dimensional measurement and automatic building-block units for size-control systems are described in Catalog 8008. Data are given on comparators, plug gaging heads, pneumatic rings, and gaging cartridges. Descriptions are given on the controller which is the basic building-block of a system; schematic diagrams help explain the operating principle. Other pneumatic instrument components used in the system are also covered.

Circle 471 on Page 17

Cutting Machines

Wink Cutter Div., Motch & Merryweather Machinery Co., 1250 E. 222nd St., Cleveland 17, Ohio—8 *page bulletin*—Automatic cutting machines for the rubber, plastics, and electrical industries are outlined in Bulletin W100. Cutting action of a machine is explained and data on the different models are given. Also noted are accessories such as a photoelectric measuring unit, stock gage, and special wetting tanks which fit into the production line ahead of the cutting machine.

Circle 472 on Page 17

Process Chromatograph

Analytical & Control Instrument Div., Consolidated Electrodynamics, 300 N. Sierra Madre Villa, Pasadena, Calif.—8 *page bulletin*—Model 26-202, a process chromatograph for the continuous monitoring or control of process streams is the subject of Bulletin 1836C. Construction design of the control unit and analyzer units is explained. A flow diagram for analyzer units is given and performance charts show the reproducibility characteristics of the instrument.

Circle 473 on Page 17

Electronic Instruments

Bristol Co., Waterbury 20, Conn.—64 *page catalog*—Indicating, recording, and controlling potentiometers and bridge instruments are described in Bulletin P1245-A. Schematic diagrams show the principle of operation for both potentiometers and bridge instruments. Features of the different models are noted, as are the type of control action for pneumatic controllers and electric controllers. Data are also given on sensing elements and attachments such as bulbs, magnetos, photocells, conductivity cells, and frequency converters.

Circle 474 on Page 17

Magnetic Amplifiers

Brach Mfg. Corp., Div., General Bronze Corp., 200 Central Ave., Newark 3, N. J.—12 *page booklet*—Facilities for manufacturing magnetic amplifiers, saturable reactors and associated circuitry are discussed. Advantages, reliability, and applications of the amplifiers and associated systems and equipment are given.

Circle 475 on Page 17

Gravity Conveyors

Lamson Corp., Syracuse 1, N. Y.—48 *page catalog*—Problems involved in handling unit loads such as cases, barrels, and wooden boxes are discussed. The solution to these problems is given by explaining the design and application of gravity conveyors. Charts and graphs are given to help select the proper conveyor for a specific load. Data are also given on accessories such as guard rails, conveying sections, and turntables.

Circle 476 on Page 17

Temperature Detection

Instrument Div., Thomas A. Edison Industries, McGraw-Edison Co., West Orange, N. J.—30 *page catalog*—Temperature indicating and alarm system using plug-in monitor units on a building-block principle is described in Bulletin 3036C. Data are given on Model 310, a monitor unit and Model 311, an indicator. Wiring and circuitry diagrams are included. Also described are resistance temperature detectors. Their construction, operating principle, and speed of response are explained. Notes are given on temperature-sensitive elements which can be used with indicating, recording, controlling, and monitoring equipment.

Circle 477 on Page 17

Motor Controls

Industrial Control Div., Arrow-Hart & Hegeman Electric Co., 103 Hawthorn St., Hartford 6, Conn.—80 *page catalog*—Data are contained in Catalog 14 on industrial motor controls such as magnetic relays, magnetic contactors and starters, reduced voltage starters, and pushbuttons and control stations. Specifications and prices are listed, along with wiring diagrams and dimensional drawings. Accessories which include door disconnects, terminal relays, and overload relays are also covered. One section of the catalog describes the replaceable parts available.

Circle 478 on Page 17

Slurry Consistency Control

Fischer & Porter Co., 832 Jacksonville Rd., Hatboro, Pa.—4 *page pamphlet*—Instrument, designated Plastometer, is the subject of Bulletin 16P1359. The device automatically measures and controls consistency of fibrous or pulpy slurries. Construction materials and design features are noted. A schematic drawing shows the control panel.

Circle 479 on Page 17

Tape-Controlled Machine

Kearney & Trecker Corp., 6800 W. National Ave., Milwaukee 14, Wis.—4 *page pamphlet*—Unit, designated Milwaukee-Matic, is the subject of Bulletin TG-59. It is a tape-controlled combination machine that mills, drills, reams, taps, and bores parts. Specifications and features are noted and sketches show the front and side view of the machine.

Circle 480 on Page 17

Inclinable Presses

Federal Machine & Welder Co., Warren, Ohio—12 *page booklet*—Line of OBI

CHOICE OF BUILT-IN VALVES GIVES CONTROL FLEXIBILITY

SINGLE AIR CONNECTION SIMPLIFIES INSTALLATION

RUGGED CONSTRUCTION ASSURES LONG LIFE

125 BELLOWS SALES AND SERVICE FIELD ENGINEERS

■ There are one or more Bellows Field Engineers in every industrial area of the United States and Canada. They will be happy to work with you in applying "Controlled-Air-Power" to your machine designs. They are listed in their local phone directories under "The Bellows Co."

758-B

Four reasons why THE BELLOWS AIR MOTOR stands first with design engineers

In designing for air cylinder operation the engineer wants first of all sure, positive control, easily interlocked to related machine movements. **He has it in The Bellows Air Motor.**

He wants simple installation, uncomplicated by cumbersome piping. **He has it in The Bellows Air Motor.**

He wants rugged construction — an air cylinder that will stand up day in and day out with minimum requirements for service and repairs. **He has it in The Bellows Air Motor.**

But he also wants the knowledge, if service should ever be needed, that it is quickly available wherever his machine may go. **He has it in The Bellows Air Motor.**

The Bellows Co.

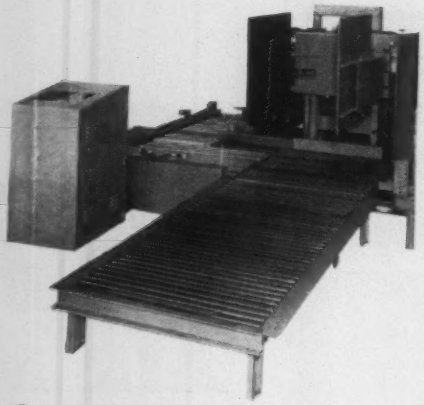
DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

AKRON 9, OHIO

This free booklet offers interesting data for the design engineer. Write for it today. Address Dept. AU359.. Ask for Bulletin BM-25. The Bellows Co., Akron 9, Ohio. In Canada: Bellows Pneumatic Devices of Canada, Ltd.

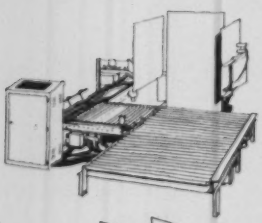
Circle 709 on Page 17

Ask Standard how to:



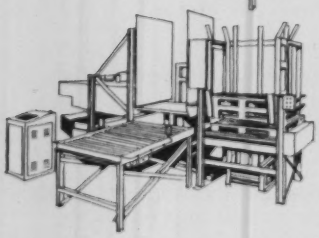
- Palletize or unitize *automatically*
- Unstack palletized or unit-loads *automatically*

Standard Conveyor Company offers a wide range of precision engineered machines for fast, automatic assembly, as well as unstacking of palletized or unitized loads — applicable to a wide variety of cased merchandise — operate at convenient low working level — faster than manual methods — save man-hours.



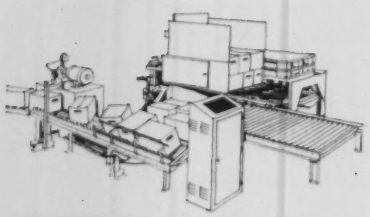
CLAMP-TYPE UNITIZER

Assembles unit-loads in desired size and shape automatically in a steady, uninterrupted flow directly from conveyor. Forms unit-loads by clamping and lifting successive layers of cases. 1800 lbs. maximum unit-load capacity; can be used with or without pallets.



LO-LOAD TYPE UNITIZER

Automatically receives individual cases from conveyor lines and arranges them into unitized load. Operates at low working level. Builds loads in successive layers of cases through finger supports which retract as layers are completed. 2500 lbs. maximum unit-load capacity; handles items packaged or bottled in glass containers.



UNITIZER UNSTACKER

Unstacks pallet unit-loads automatically, up to 45 cases per minute. Lifts load from pallet (which is automatically moved into pallet stacker). Successive layers of cartons are released and single cases fed onto outgoing conveyor line.

INVESTIGATE — send for literature and complete information on machines suitable for your merchandise. Write Dept. EE-3, Standard Conveyor Company, North St. Paul 9, Minnesota.

Standard
GRAVITY & POWER
CONVEYORS
Sales & Service in Principal Cities

OVER 50 years of conveyor experience

Circle 710 on Page 17

presses in capacities from 40 to 200 tons is described in Bulletin 52112. Tables list specifications and crankshaft capacities. Outline drawings show the different parts in the presses and photos of special OBI presses are given.

Circle 481 on Page 17

Lubricating Equipment

Lincoln Engineering Co., 5794 Natural Bridge Ave., St. Louis 20, Mo.—32 page catalog—Lubricating equipment for automatic or semiautomatic machines which have a rotating, sliding, or reciprocating surface, are described in Catalog 81. Sketches show the different methods of installation. Data are given on controls and accessories for automated centralized systems. Some of the accessories covered include: Air couplers, hose, filters, air gages, valves, and pressure switches.

Circle 482 on Page 17

Press Scrap & Chip Handling

Prab Conveyors Inc., 30121 Groesbeck Hwy., Roseville, Mich.—14 page booklet—Bulletin S-90 pictorially outlines a steel belt conveyor system for press scrap disposal, a tubular conveyor which removes chips from machine tool units, and steel belt conveyors which remove turnings, chips, or parts from machine tools. Illustrative examples show the flexibility and adaptability of the automatic scrap and chip disposal units.

Circle 483 on Page 17

Pillow Block Bearings

Hoover Ball & Bearing Co., 5400 S. State Rd., Ann Arbor, Mich.—12 page booklet—Line of pillow block and flange bearings, furnished in sizes from 1/2 through 1 3/16 inch is described in Bulletin 106. Data are given on construction materials and dimensional drawings show flange mountings and spherical seat machine units. Tables list load rating information.

Circle 484 on Page 17

Time Switches

Tork Time Controls Inc., Mount Vernon, N. Y.—8 page bulletin—Time switches with plain 24-hour dials, weekend skip dials, 7-day dials, astronomic dials, and intermittent program dials are outlined in Catalog 159. Suggestions are given for selecting the right time switch with the proper switch action. Also discussed are the correct applications in using single or double-throw; single, double, or three-pole; or two-circuit switches.

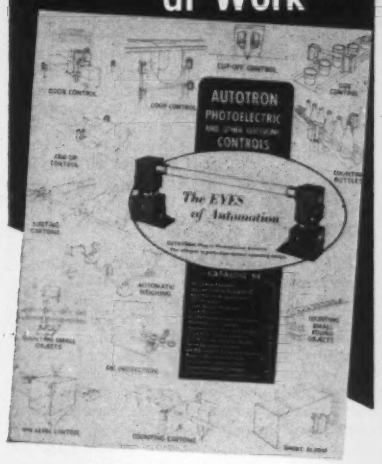
Circle 485 on Page 17

Jig Borer

Pratt & Whitney Co. Inc., Charter Oak Blvd., West Hartford 1, Conn.—6 page pamphlet—Model 4EA, a precision numerically controlled jig borer with a 70-inch height capacity and 80-inch bolt circle capacity, is the subject of Bulletin 622. Operation of the electro-limit measuring system and the dial-type numerical control is explained. Design of the cabinet which houses the controls and the tape reader is discussed, as is the column structure of the jig borer.

Circle 486 on Page 17

EYES of Automation at Work



New AUTOTRON Catalogs show wide selection of modern industrial photoelectric equipment including the latest in tubeless controls. Also application diagrams of automatic conveyor control, inspection, carton sorting, smoke detection, die protection, counting, weighing, limit and tension control, conveyor jam-up control, spraying and processing control, ramp traffic control, etc.

Send for your copy today.

AUTOTRON, INC.

Box 722RRN Danville, Ill.

Representatives in principal cities

Circle 711 on Page 17

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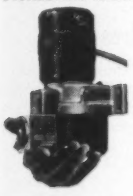

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Utility Pumps

Continental Pump Co., 1027 S. Vandeventer Ave., St. Louis 10, Mo.—8 page bulletin—Utility pumps for various kinds of transferring, circulating, metering, and spraying jobs are outlined in Bulletin CP-3489. Construction of the pump, which uses the helical screw principle, is explained. Charts list the capacities of the different models which are furnished up to 50 gpm and pressures up to 150 psi.

Circle 487 on Page 17

Pulse Transformers

PCA Electronics Inc., 16799 Schoenborn St., Sepulveda, Calif.—24 page handbook—Low-level pulse transformers, their theory, methods of measurements, and manufacturing procedures are discussed. Applications are noted and the interchangeability of the transformer is explained. Electric specifications, dielectric ratings, and case types are also included.

Circle 488 on Page 17

Magnetic Amplifier Systems

Magnetic Amplifiers Inc., 632 Tinton Ave., New York 55, N. Y.—8 page bulletin—"Magnetic Amplifier Systems For Nuclear Reactor Installations" is the title of Bulletin S-963. Details of magnetic amplifier servo drives and applications in nuclear drive systems, covering control rod drives, hydraulic valve control, and remote handling control are given. Data are included on static magnetic switching systems used in reactor control circuits, programming and simulators, magnetic amplifier voltage/current regulators, and regulated dc power supplies.

Circle 489 on Page 17

Torque Control

Electric Products Div., Vickers Inc., 1815 Locust St., St. Louis 3, Mo.—4 page pamphlet — Magnetic-particle clutches and brakes which provide flexible torque control and power transmission without chatter, grab, or wear are described in Bulletin 6000-A. The magnetic-particle principle is explained. Also included are outline dimensions and performance charts.

Circle 490 on Page 17

Flexible Shafting

F. W. Stewart Corp., 4311-13 Ravenswood Ave., Chicago 13, Ill.—8 page bulletin—Bulletin 539 discusses the use of flexible shafting in products which require control from remote places. Charts list specifications for both remote control and power drive cables and notes are given on selecting the proper type. The different types of flexible casing are described, with suggestions for the proper selection of a casing. Also included are data on adapters for flexible shafts.

Circle 491 on Page 17

Automatic Batching Systems

Toledo Scale Corp., Toledo 12, Ohio—8 page bulletin—Systems for batching operations involving such industries as concrete, food, glass, or metal are described in Bulletin 2964. Large panels which interlock batteries of scales into automatic control systems, as well as compact units covering one or more ingredients are covered. Data are given on entire systems,

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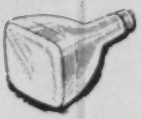

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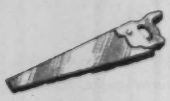

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Circle 714 on Page 17

including scales, controls, cutoff, hoppers, feeders, gates, and conveyors. The remote setting of formulas and remote recording of digital data for complete batch control and recording is also discussed.

Circle 492 on Page 17

Automation Planning

General Electric Co., Schenectady 5, N. Y.—8 *page bulletin*—Bulletin GED-3684 entitled "Planning For Flexible Automation" explains five steps toward establishing the use of numerically-controlled machines in a manufacturing plant to make possible the economic production of job-lot orders and prototype development. Case histories are described which show the advantages of this type of control system.

Circle 493 on Page 17

Power Amplifiers

Servocontrol, Div., Oilgear Co., 1560 *W. Pierce St., Milwaukee 4, Wis.*—4 *page pamphlet*—Data on servocontrol power amplifiers are given in Bulletin 36200. The amplifiers can be used to drive two phase ac servomotors or dc torque motors while providing for command-feedback input signal summation, comparison, or difference. Dimensional drawings, block diagrams, and wiring diagrams are included.

Circle 494 on Page 17

Fluid Metering

Builders-Providence Inc., 345 *Harris Ave., Providence 1, R. I.*—12 *page booklet*—Bulletin 100-P6 describes methods for selecting throats and capacities for Dall flow tubes, venturi tubes, and venturi nozzles. Formulas and tables are given to help pick the proper throat size and calculate the head loss in various applications. Illustrative examples of formula application are worked out to determine factors such as the pumping cost per year for differential producers under typical conditions.

Circle 495 on Page 17

Service Valves

Barksdale Valves, 5125 *Alcoa Ave., Los Angeles 58, Calif.*—20 *page booklet*—Line of valves, suitable for oil, water, or air with pressure ranges from vacuum to 10,000 psi, is described in Catalog 59-60. The "Shear-Seal" design principle is explained. This principle primarily consists of a pressure balanced, self-aligning, tubular seal which is constantly in contact with an optically flat porting disc. Flow patterns are given, as are illustrations of 4-way, 3-way, shut-off, and diverter valves.

Circle 496 on Page 17

Rotary Blowers & Gas Pumps

Sutorbilt Corp., 2966 *E. Victoria St., Compton, Calif.*—8 *page bulletin*—Rotary positive pressure blowers and gas pumps and their uses in air and gas handling operations are discussed in Bulletin S-59G. The operation, construction, types of drive, timing gears, and thrust bearing assembly of rotary blowers are described. A chart outlines performance characteristics of 20 different blowers and pumps.

Circle 497 on Page 17

Control Cables

Chester Cable Corp., 93 *Oakland Ave., Chester, N. Y.*—6 *page bulletin*—Data are contained in Bulletin ECC-1-58 on plastic insulated and jacketed electric control cables rated at 600 v. The types of cable covered include small diameter control cables, municipal signal control cables, supervisory control cables, station control cables, and flexible control cables. Insulation and jacketing materials and color coding method are described.

Circle 498 on Page 17

Contactors & Relays

Rowan Controller Co., 2313-15 *Homewood Ave., Baltimore 18, Md.*—16 *page booklet*—Line of special purpose relays and contactors rated from 10 to 75 amp is described in Bulletin B. Data on specifications, mounting positions, coils, contact resistance, and heat rise are given. Drawings show make and break features; performance charts show interruption curves and surge curves.

Circle 499 on Page 17

Flexible Couplings

Mechanical Power Transmission Div., Zurn Industries Inc., Erie, Pa.—4 *page pamphlet*—Design and features of continuous sleeve flexible couplings are noted in Bulletin 502. Suggestions for selecting the proper coupling and recommended lubrication specifications are given. Assembly and disassembly instructions are also included, and charts list ratings and dimensions.

Circle 500 on Page 17

Bar & Tube Machinery

Foundry & Mill Machinery Div., Blaw-Knox Co., 300 *Sixth Ave., Pittsburgh 22, Pa.*—18 *page booklet*—Data are given in Bulletin 2533-JJ58 on bar and tube machinery suitable for billet peeling, billet chipping, centerless turning, wire straightening and cutting, stretch straightening, and roll grinding. Numerous illustrations point out the features and applications of the different units.

Circle 501 on Page 17

Dew Point Controllers

Surface Combustion Corp., 2375 *Dorr St., Toledo 1, Ohio*—6 *page pamphlet*—Automatic dew point recorders and controllers are outlined in Bulletin SC-181. Systems for the control of carbon potential and their applications are discussed, with a chart included for selecting the proper system. Operating principle is explained and photos show the installation procedure.

Circle 502 on Page 17

Enclosed Limit Switches

Micro Switch, Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.—20 *page booklet*—Details are given in Catalog 83c on nine housing groups of metal-enclosed switches for industrial use. Some of the types of units described include: Explosion-proof, maintained-contact, prewired, hand-operated, and sealed switches. Factors to consider in selecting a switch are

discussed and definitions of some of the terms used are included.

Circle 503 on Page 17

Data Processing System

Systems Div., Beckman Instruments Inc., 325 N. Muller Ave., Anaheim, Calif.—6 page pamphlet—Model 210, a data processing system capable of receiving up to 1000 input signals, is the subject of Bulletin 3017. A block diagram shows the operation of the system. Features of the unit are described and typical applications, such as the processing of data from wind tunnels, are described.

Circle 504 on Page 17

Variable-Speed Pulleys

Lewellen Mfg. Co., Columbus, Ind.—24 page catalog—Data are contained in Catalog 70 on variable-speed and combination pulleys. The different types of pulley controls are explained and factors to consider when selecting a drive are mentioned. Charts list sizes, ratings, and speed ranges.

Circle 505 on Page 17

Closed-Circuit TV Equipment

Kin Tel Div., Cohu Electronics Inc., 5725 Kearny Villa Rd., San Diego 11, Calif.—8 page bulletin—Line of closed-circuit television equipment is described in Catalog 6-103. Data are given on components in the system which include cameras, camera housings, control panels, and monitors. Illustrations show typical applications of different systems.

Circle 506 on Page 17

Saturable Reactors

Control, Div., Magnetics Inc., Butler, Pa. —4 page pamphlet—Physical and electrical characteristics of proportioning reactors, transductors, switching reactors, and preamplifiers are outlined in Bulletin C-15-S. Dimensional outlines and specification tables are given, as are ordering instructions.

Circle 507 on Page 17

Automatic Buffing Machines

Wilson Buffing Chuck & Machine Co., 22730 Dequindre, Warren, Mich.—6 page pamphlet—Automatic polishing and buffing machines for continuous straight line, rotary, or reciprocating action are described. Illustrations show the different types of buffing heads available and the conveyors for mounting the single or multiple heads.

Circle 508 on Page 17

Adjustable Speed Drives

Servo-Tek Products Co., 1086 Goffle Rd., Hawthorne, N. J.—16 page booklet—The basic methods for operating dc motors from ac power sources are discussed in Catalog 11058. Schematic diagrams of the three most used systems are given. Construction details are also given and tables list specifications, speed, and torque ratings.

Circle 509 on Page 17

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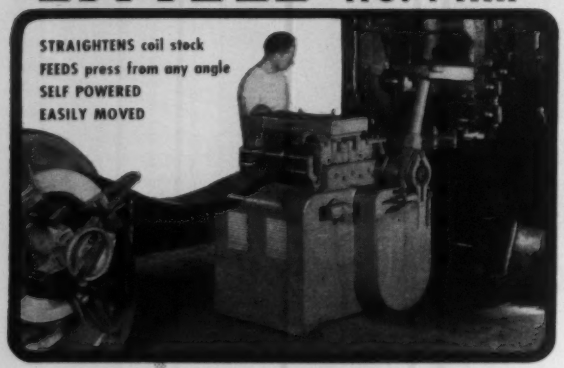

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Circle 719 on Page 17

COMPUTER CONTROL OF CONTINUOUS PROCESSES

By I. MELVILLE STEIN
President
Leeds & Northrup Co.
Philadelphia, Pa.

SOME producers of computers who have only recently attempted to enter the field of automatic control of continuous processes appear to be promising too much, too soon. Among these newcomers to the automatic process control field are companies whose competence in the field of computer techniques is excellent. But there is much more to the automatic control of continuous processes than sound computer techniques.

There is room for concern about the setback computer control may experience if, as the result of promising too much, too soon, there are many disappointments in actual performance. This situation has already developed in some applications of computers to office procedures. Notwithstanding the tremendous success of computers in certain technical, statistical, and military applications, there have been too many unsuccessful office applications. In these cases, after the expenditure of much time and money in preparatory work, and the purchase of expensive equipment, the promised savings or other benefits often have not materialized.

Refined Automatic Controls

In order to establish the role of computer controls in proper perspective, a brief review of some significant steps in the development of refined automatic controls will be useful. The earliest automatic regulating controls that came into general use were speed governors, first used on steam engines and then on steam turbines. Later, there were the simpler forms of damper controls for furnaces. To avoid oscillation, or hunting, all of these controls were stabilized by giving them a "drooping" characteristic. That is, in the case of speed control, as the load was increased on the engine or turbine, the governor maintained a progressively reduced speed. To reduce this change of speed with load, there were developed so-called isochronous governors. The word means constant time, and the name indicates that they held constant speed—actually, they did not.

With ample power available to drive them, and through excellent design, these isochronous governors were much more sensitive than their predecessors, and in going from light load to full load the variation in speed was much reduced. But the drooping characteristic was still there to give stability. They served very well in their day, but would be quite inadequate for, say, a modern, large scale electric power system. The required constancy of frequency is now controlled by very sensitive electrical devices responsive to the generated frequency.

It was not until 1917 that controls were devised which, while retaining the stability of the earlier controls, effectively eliminated the drooping. This opened the way to automatic control at a fixed value regardless of changes in load or other variables.

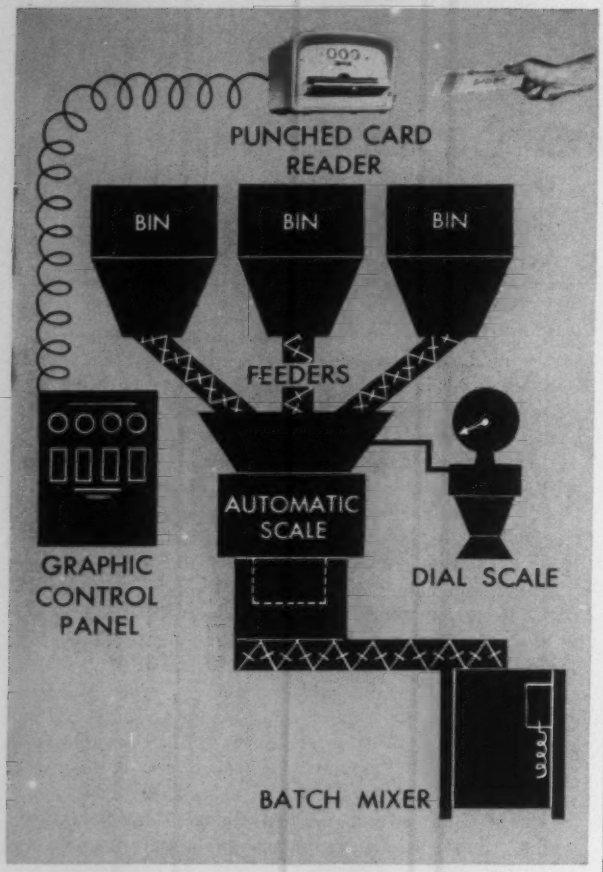
The manner in which this development occurred is of interest. Morris E. Leeds, by about 1910, had succeeded in devising chart recording instruments for temperature measurements in industrial plants. These recorders were of the null, or balance type, utilizing potentiometers in Wheatstone bridge circuits. The use of these sensitive recorders in industrial processes brought to light theretofore neglected process phenomena now frequently referred to as process lags. Leeds analyzed these effects, defined them in mathematical terms, and devised instruments and apparatus to control them.

The initial action in Leeds temperature controls followed earlier practice of providing stability by the use of the "drooping" characteristic, but included creation of an auxiliary electromotive force which was fed back into the control circuit to return the temperature to a fixed value regardless of load and other conditions. This auxiliary electromotive force was applied in such a way as to return the temperature to a fixed or normal value as quickly as process lags would permit. This was accomplished by making the feedback responsive not only to the magnitude of the departure from normal, but also to the rate of return to normal.

Thus, in controlling temperature, assuming the temperature to be below normal for some reason, heat would be applied to prevent further reduction in temperature. In addition to this action, the control would start to add more heat so as to bring the temperature back to normal at the maximum rate that could be tolerated without causing overshooting or oscillation. This maximum rate was fixed primarily by the process lags.

Consider Control Requirements

In early applications of comprehensive and coordinated systems of automatic control, such as those applied to large boiler furnaces, the refinements in the controls could not be made fully effective because of the lags and other limitations in the process itself. Today, in designing a new process plant, the con-



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trol requirements are considered from the very outset. This, of course, is essential if optimum control is to be achieved, since full advantage of advanced forms of control cannot be realized unless the process plant itself is susceptible to such control.

As the advantages of refined automatic control became more fully recognized and as process plants were improved to be more susceptible to refined control, the error and time lag in recorder mechanisms became limiting factors which it was desirable to eliminate. This led to the development of direct or "blind" controllers which performed their control function directly—that is, without going through a recorder mechanism. High speed electronic feedback controls of this type were used for positioning valves and similar regulating devices and also for speed control of electric motors. The recorder, when added to such systems, became an adjunct to provide assistance in attuning the control to the process and in spotting and analyzing quickly any disturbances that might occur either in the control system or in the process itself. Such control systems are still undergoing development and improvement to make them better for today's needs and to adapt them to the needs of the future.

About two or three years ago, some technologists active in the field of process controls expressed the view that it was not worthwhile to further improve such direct control systems because they would soon be made obsolete by the use of direct control from computers. However, it seems inconceivable to me that in large scale continuous processes a single complex unit would be entrusted with the basic control—if anything went wrong with the one complex unit, all control would be lost. This position is supported by the consideration that much of the first cost and the maintenance cost of such control systems would be necessary anyway, even with computer control.

In other words, individual, process-variable controllers are here to stay, and computer controls will be in the nature of an additive refinement so that, if the computer should fail to function properly, only the additional refinement which it contributes would be lost. The conventional control system would then continue to provide stable operation as it did before the computer refinement was added.

Role of Computer Control

Thus, computer control offers not a substitute for present conventional control, but a refinement achieved by addition to such control. The full realization of this additional refinement will depend upon the extent to which the process itself is susceptible to refinement.

As an intermediate step toward computer control, a computer can be of great value in analyzing the static and dynamic characteristics of the process to determine where the process operation may be improved from a control point of view, and to appraise the prospects of the advantages to be gained by adding computer control. A logging system provides a periodic readout, in digital form, of all the process variables and provides an auxiliary readout, also in digital form, of abnormal performance at any of the control points or of any other process variables. This latter feature permits

the plant operator to adjust the individual control points to give the optimum performance attainable in the process as it exists. Additionally, the computer may be used to calculate involved relationships and to print out "operating guide" type information.

Both the intermediate and the ultimate use of computers to improve the control of continuous industrial processes involve programming of the computer. This requires determining the static and dynamic characteristics of the process and then adjusting the programming element of the computer to take these characteristics into account. For the programming adjustments to be correct for a reasonable length of time the characteristics of the process itself must be stable over that interval, regardless of such factors as changing ambient temperatures and cleanliness of the system.

It is possible by using what some control technologists have called "adaptive control" to have the computer automatically readjust its own programming to take into account changes in one, or a few, of the process characteristics. However, if many of the characteristics require such treatment the use of adaptive control can readily become impracticable.

Regarding continuous industrial processes themselves, technologists of operating companies have made, and are making, extensive studies of process dynamics. However, much remains to be done in this field before the prospects for full computer control can be properly appraised.

What Are the Limitations?

It is interesting to speculate as to what will place the ultimate limit on computer control of continuous industrial processes. Will it be the limitations of the computer controls, or will it be the limitations of the process itself? Some of the leading technologists in the process industries feel that the limiting factor will be the computer controls rather than the process.

As an optimist engaged in the development and production of computer controls, I feel that the ultimate limit will not be in the controls. Based on past experience in the development of refined controls, I expect sort of a "see-saw" pattern in which both the controls and the process plant are continually improved, with the limitation shifting with time from one to the other. At any one time, of course, the capability of the controls might be in advance of the capability of a particular process or plant to respond. In another particular process or plant the reverse might be true.

Probably the ultimate limit will be an economic one, wherein refinements in both the controls and the processes will have reached points of diminishing return so that further refinements in either would not be economically justifiable. In any event, we are a long way from ultimate accomplishment in either category.

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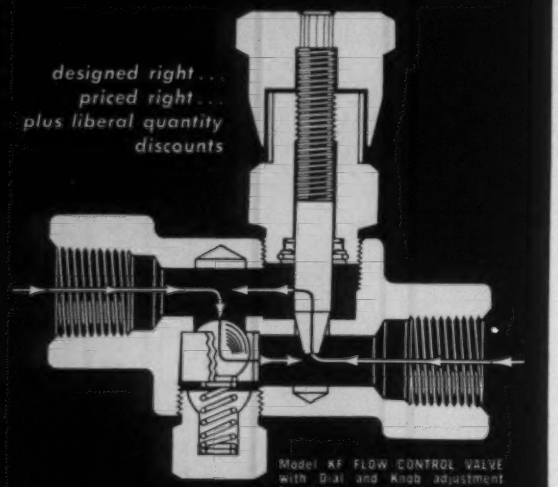

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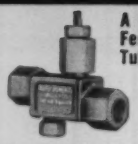

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development projects which constitute improvements and extensions of existing process control systems. Computer control has already entered these developments in a major way, but the full extent to which it will be found justifiable is not yet clear. Neither is it clear whether the computers to be used in the ultimate developments will be of the digital or analog type. Probably there will be need for both.

For installations where they are applicable, analog computers, presently at least, are likely to be simpler, more reliable, and less expensive than digital computers. Also, analog computers are very useful and rather widely used in "ratio" and "cascade" control systems.

Electronic analog computers, utilizing dc signals for both the input and output circuits, provide great flexibility and permit combining the computer signals for various computing operations. This same flexibility makes these computers especially adaptable for use in end-product control from suitable analyzing instrumentation.

An outstanding example of control through the use of combined or co-ordinated control systems is found in the comprehensive and complex continuous processes involved in the electric utility industry. Here, automatic control problems fall into three general categories: 1. The heat generation. 2. The electrical energy generation. 3. The transmission of the electrical energy to the points of ultimate use. Although control systems for each of these categories have been developed as more or less separate entities, they are already being tied together to some extent into one comprehensive system. In the ultimate development all three categories are expected to be fully co-ordinated. Of course, this must be done, to the fullest extent possible, in ways that will isolate any failure to its own area and will not cause disturbances in other areas of control.

Where possible—and it may not always be possible—it is better to segregate the whole complex process into several discrete major parts and to do a thorough job of controlling each of these parts, instead of attempting as the first step to control the whole comprehensive system. When really satisfactory control of each such discrete major part has been achieved, it should not be difficult to co-ordinate the several parts to provide sound over-all control, particularly if this ultimate goal is kept in mind from the outset. I believe that this procedure will not only shorten the time to achieve ultimate success, but will produce more reliable over-all control of a comprehensive system.

Field Installations

Analog computer control is already in use in the generation and transmission categories of electric utility system operation. An L&N computer of this type was installed on the Southern Co.'s network approximately five years ago. This control was installed to determine the generation at various sources for optimum transmission efficiency. It was estimated to save the full cost of the installation in one year. The actual savings, from loading units in accordance with computer directions, have exceeded the estimated savings by about 100 per cent. Additional savings are

expected when full automatic operation is completed.

Another analog computer control, known as a "desired generation computer," was installed on the Southern California Edison system in Sept. 1958. In this arrangement, programming is done by an operator setting a number of dials to "instruct" the computer. From then on, the control is fully automatic. Computer controls of this type are presently being built for several other interconnected power systems.

In the field of digital computers applied to industrial process control, a little under a year ago Leeds & Northrup Co. made its initial installation at the Esso Refinery in Baton Rouge. After preliminary adjustments had been completed, this unit went into 24-hour line operation on July 1, 1958. Although adaptable to full automatic control, this computer is presently used as a guide to the operators and for system studies which are essential prior to attempting full control. The 24-hour line operation continued for 24 days before a computer component failed. There have been additional failures of this same type. These failures were promptly corrected by replacing the defective components, and were not serious in the present service of the computer. However, for full computer control more reliable computers are needed.

From an address entitled "The Outlook for Computer Control" presented at the 14th Annual Symposium on Instrumentation for the Process Industries, conducted by the Dept. of Chemical Engineering, Agricultural and Mechanical College of Texas, Jan. 1959.

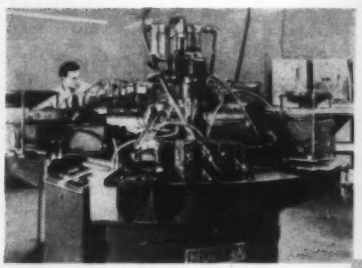
AUTOMATION STANDARD PERMITS DESIGN, MANUFACTURING ECONOMIES

By JOSEPH HARRINGTON Jr.
Head, Mechanical Engineering Section
Arthur D. Little Inc.
Cambridge, Mass.

STANDARDIZATION made in one portion of the electronics industry has produced true economies for designers, production managers, and consumers. I refer to the adoption of automation standard RS-188 of the Electronic Industries Association. This standard defines a module for rectangular grid systems used in the physical layout of electronic components in devices including radio and television sets. The grid specified in the standard is now almost universally used by electronics equipment manufacturers who use printed wiring boards.

The Old Way

Prior to adoption of printed wiring boards and the modular grid concept in their construction, design of a television set, for example, was by relatively haphazard means. Beginning with a breadboard model of the circuit, engineers selected components such as transformers, tubes, and sockets whose quality and price were appropriate. These were fastened to a sheet metal base, in an arrangement which seemed good to the engineer, with their electrical terminals protruding at random angles and heights above the base plate. Circuit ele-



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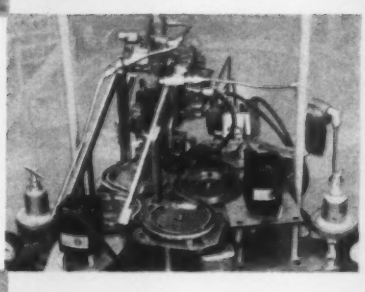
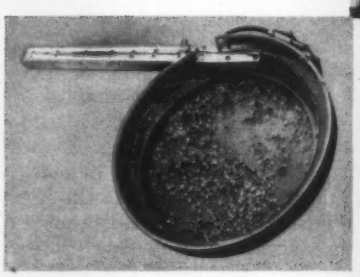


SINGLE STATIONS
for established production lines.



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ments such as resistors and capacitors, which were very light in weight relative to the stiffness of the wiring, were simply festooned between these terminals.

When such an arrangement prototype had been built, tested, and approved, manufacturing consisted of duplicating it, say, half a million times. Large components were fastened to the punched base, and then 100 or more operators assembled the smaller components, twisted and clipped wires, soldered, and tested. A labor cost of $2 per set was not unusual for this type of work. Such assembly was also subject to considerable human error. For example, an operator could easily pick up a resistor of the wrong value or wire it between the wrong terminals.

New Concept

Introduction of the printed wiring board made possible a significant change in this technology. Printed wiring boards are made by laminating sheet copper to a phenolic laminate plate, and then etching away the copper except in strips and spots necessary to form the wiring pattern of the circuit. Holes are punched so that the lead wires of the electrical components may pass through the board and be soldered to the wiring pattern. Thus the printed wiring board not only supports the components in place of a metal chassis, but it replaces the wiring harness with a component.

Automation Possible

This construction method has some useful byproducts beyond the obvious benefits of assured accuracy in wiring. Because all the wiring is in one plane, all the soldering is done in one plane. It is therefore possible to touch the board to the surface of a solder bath and perform all the connections at once. Also, all other components are attached to the single element printed wiring board; no longer is one component pyramided upon another.

This last factor opened the way to mechanical placement of components. If all the elements were delivered to assigned places in a single plane, why could not a machine perform the physical assembly? The answer is that it can; many automatic assembly machines of several different types have been built.

On one such automatic machine, 30 or more components can be placed on a board in sequence as the board is conveyed past a series of operating heads. Operator productivity with this machine, in terms of completed circuits per manhour, has been increased tenfold over previous manual methods.

Standards Needed

It soon became apparent that automatic assembly machines, if they were to work reliably, had to be fed with mechanically uniform components. The machine could not economically do what a human could do in unscrambling tangled and kinked lead wires, or matching irregular and nonuniform components to the holes in the wiring board. Furthermore, since it is a normal function of purchasing agents to buy from several sources, there was often no dimensional or geometrical uniformity in the components made by various manu-

Circle 724 on Page 17

facturers, even though they had identical electrical characteristics. Component standardization was urgently needed.

A machine such as the one described, which can produce a finished assembly every 2 or 3 seconds, may cost over $100,000. Because of the large investment, such a machine must be fully adaptable to a wide variety of production items. A unit of this machine which places half-watt resistors, for example, is tooled to form lead wires and place them in pairs of holes a given distance apart. This distance, in the form of hole spacing, had to be the same on every type of wiring board that was to receive half-watt resistors. To some extent the spacing was determined by the length of the body of the resistor. Here again, standardization was urgently needed.

Many other factors were involved in standardization for automatic assembly: Spacing of punches for perforating the wiring boards; dimensions of component bodies and the spacing between lead wires; tooling of the insertion heads in the assembly machines; programming of progressive punching and assembly machines; electronic characteristics of conductors at given distances from one another, etc.

Establishment of Standards

A major solution to standardization problems lay in the adoption of a rectangular grid system governing the mechanical configurations of circuit elements. Printed wiring boards are laid out using this grid system, and wherever possible the points of attachment between components and the board are made to fall at intersections of the grid. Components are manufactured with lead spacings corresponding to multiples of the module, so that they may be inserted without modification. Machines are designed with tools and indexing heads built to conform to the module.

In order to cover the present and anticipated range of sizes of electronic circuits, a small module—0.025 inch—was adopted as a base, and preferred multipliers were indicated. For the usual circuits associated with miniature vacuum tubes, a multiplier of four gives a convenient 0.1 inch grid, which is now almost universally used. Smaller multipliers of two or one may be used as miniaturization proceeds.

The grid system preserves full flexibility in the design of printed wiring boards and in the selection of component sources. It permits the selection of any one of several automatic assembly systems with no loss in design freedom or machine adaptability.

Standard RS-188, "Standard Dimensional System for Automation Requirements," was adopted by the Electronic Industries Association in June 1957 as a result of the diligent efforts of its Committee A-3 of the Automation Equipment and Computer Panel. It has also been adopted by the International Electrotechnical Commission. It can safely be said that this standard has made possible sizable savings in the design and automatic production of electronic equipment.

From a paper entitled "Standardization—A Case Study from the Electronics Industry" presented at the 9th National Conference on Standards of the American Standards Association, New York, Nov. 1958.

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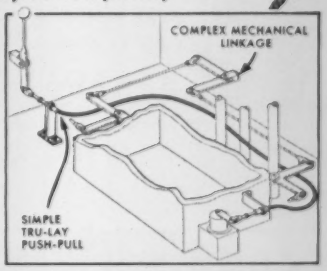

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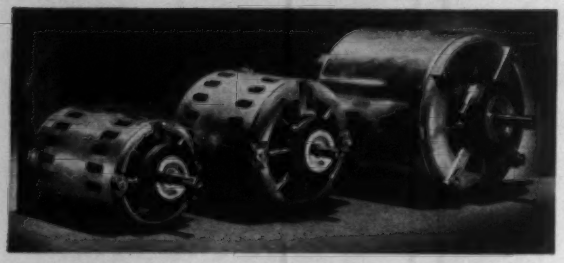

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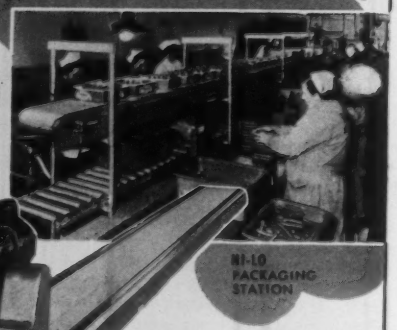

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STATUS OF NUMERICAL CONTROLS

By H. W. MERGLER
Asst. Prof., Mechanical Engineering
Case Institute of Technology
Cleveland, Ohio

TODAY, almost every major builder of machine tools is engaged in the development and application of the concept of numerical control to his product. Areas of application in the metalworking industry alone include milling, boring, turning, drilling, shaping, flame cutting, welding, punching, casting, riveting, and shearing.

Retrofit Considered

Sometime during the period when the machine tool builders began to contemplate the application of numerical control to their products, the idea developed that these automatic control techniques could be applied to the builders' standard lines without any extensive re-engineering of the basic machine tools. This idea was probably nurtured by economic considerations as well as lack of experience in this new area of technology. However, the results achieved in almost all cases were at best nominal when the factors of control equipment costs and the potential attainments of the basic machine tools were compared to the results obtained from numerical control operation.

Early Experience

The principal criterion for machine tool quality was then quantity or massiveness of components, rather than dimension and critical distribution. The attempted application of servo control to standard lines clearly indicated the following:

1. The mass distribution and component dimensions within the controlled machine must be such as to eliminate resonance, deflection, and lost motion within the operating range of the controlling servo, and also not adversely affect the control's response due to reflected inertias.
2. The design techniques must permit quantitative prediction of the static and viscous frictions of the tool slides, and values of reflected cutter loads, throughout the machine tool's range of operation. Manufacturing methods must be controlled so that the product will consistently meet the design objectives.

Transfer of Responsibility

Since machine tool builders have accepted the fact that many areas of the designer's art must be approached in a more quantitative manner, the servo engineer can now synthesize a control system to operate on minimized inertias and frictions, and on reflected tool loads of known magnitudes—the mechanical designer is no longer the limiting factor. Instead, the machine tool builder is now painfully aware of two additional limiting factors. These are:

1. The control system (logic elements, servomechanism, and transducers) must be considered parasitic to the machine tool. This fact must be reflected in the comparative price of the machine tool and its control.
2. The parasitic elements necessary to achieve numerical control of a machine tool are constructed from

components not designed specifically for machine tool application, and which are generally characterized by short-term reliability and high cost. In many cases this is due to design features which are not significant to the machine tool builder in his application.

Summary

In summary, the machine tool builder has recognized the necessity of designing machine tools *for* numerical control. He can now confidently describe, in quantitative terms, the dynamical environment into which a parasitic control system must operate.

The fact that critical control components have not been developed *for* machine tool use is the greatest single factor responsible for retarding the advance of numerical machine tool control. Since the basic requirements of machine tool control components are not the same as those for components in other areas of control, the relative importance of such factors as weight, size, cost, and reliability must be evaluated here as being overwhelmingly weighted toward reliability and cost.

The machine tool builder is now critically examining each parasitic element of his control system with a view to reducing its cost and improving its reliability. The actual implementation of these objectives can best be performed by the control manufacturer. This would avoid repetition of a historically analogous situation where machine tool builders, through necessity, developed rudimentary items such as limit switches and solenoids to a level suitable for machine tool use. Industrial co-operation would permit the early realization of integrated machine tool control systems representing an economic balance of machine and control with a more nearly common standard of reliability between them.

From a paper entitled "The Limiting Influence of Available Control Components on Numerical Machine Tool Control Design" presented at the joint AIEE, ASME, IRE Conference on Automation Techniques, Detroit, April 1958.

SELECTING FIRE-RESISTANT FLUIDS

By C. T. LEWIS
Chief Lubrication Engineer, Republic Steel Corp.
Cleveland, Ohio

PRIMARY considerations involved in selecting a fire-resistant fluid are discussed. These include toxicity, flammability, solubility of contaminants, operating temperatures and pressures, types of pumps, fluid viscosity, and economics. Final choice of equipment and fire-resistant fluid usually represents a compromise among desired features. Examples are given of problems which can arise as a direct result of physical or chemical changes within the fluid or due to other mechanical or physical conditions.

From a paper entitled "Considerations for the Application of Fire-Resistant Fluids" presented at the 1958 *Iron and Steel Convention of the AISE, Cleveland, Sept.* 1958.

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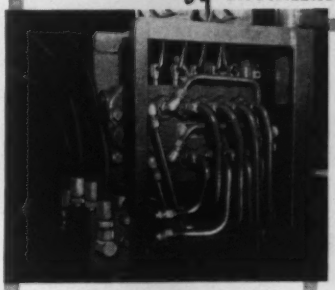

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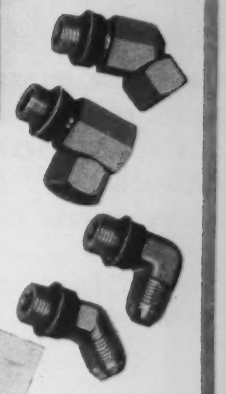

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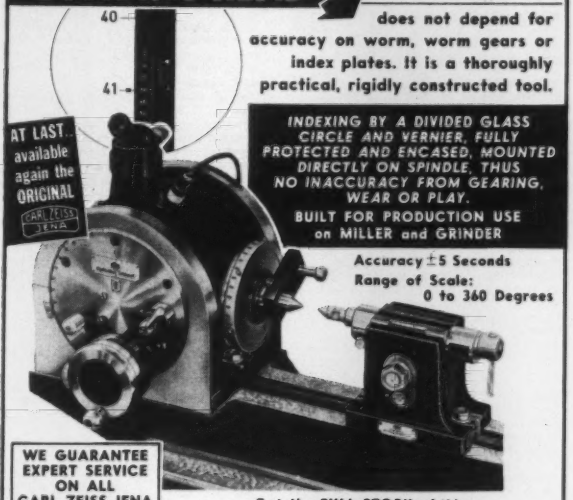

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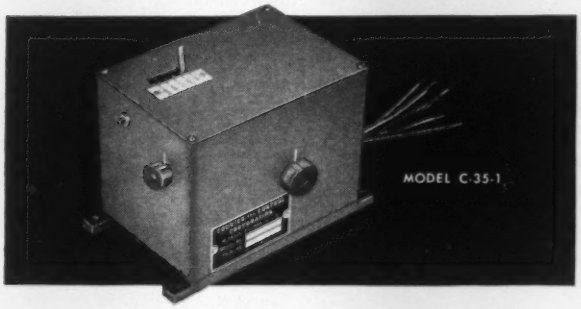

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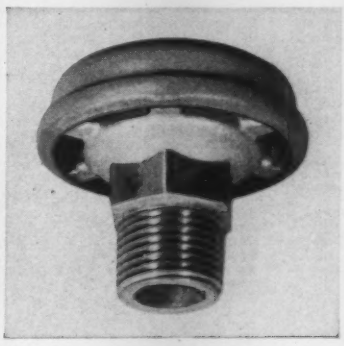

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By the late Donald P. Campbell, consulting engineer; 316 pages, 5¾ by 9 inches, published by John Wiley & Sons Inc., New York; available from AUTOMATION; *$10.50 postpaid.*

Basic topics in process physics covered are: Kinematics of materials handling; fluids in motion; forming, propulsion, and guidance; thermal process dynamics; mass transfer dynamics; and chemical process dynamics. Detailed discussions include topics such as: How to choose the size of a blender; need for web guidance and methods of manipulation.

Association Publications

DEVELOPING EXECUTIVE SKILLS

Clothbound, 431 pages, 6 by 9¼ inches; available from American Management Association, 1515 Broadway, New York 36, N. Y.; $9.00.

Based on material prepared by 38 major contributors, book presents discussions of management development programs, tools, and techniques. Specific experiences in large and small companies are also reported. A list for supplementary reading in management development is appended.

BOOK OF ASTM STANDARDS—PART 1 FERROUS METALS SPECIFICATIONS

Available from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.; 1594 pages, 6 by 9 inches; $12.00.

The first of ten parts, this volume is composed of 18 subdivisions presenting 291 standards. Various steel materials, wrought iron, cast iron, malleable iron, ferro-alloys, metal powder products, titanium, and titanium alloys are among the materials covered. Part of the 1958 Book of ASTM Standards, the volume can be kept up to date by supplements to be issued late in 1959 and 1960.

MOTORS AND GENERATORS

Looseleaf, 285 pages, 8½ by 11 inches; available from National Electrical Manufacturers Association, 155 E. 44th St., New York 17, N. Y.; $10.00.

NEMA standard publication MG1-1959 supersedes their previous publication MG1-1955. It sets forth pertinent definitions, ratings, dimensions, frame sizes, tests, performance characteristics, and application data. Devices covered include ac and dc motors and generators. Special sections are provided on definite-purpose motors, synchronous motors, dc generators, synchronous generators, motor-generator sets, and motors over 200 hp.

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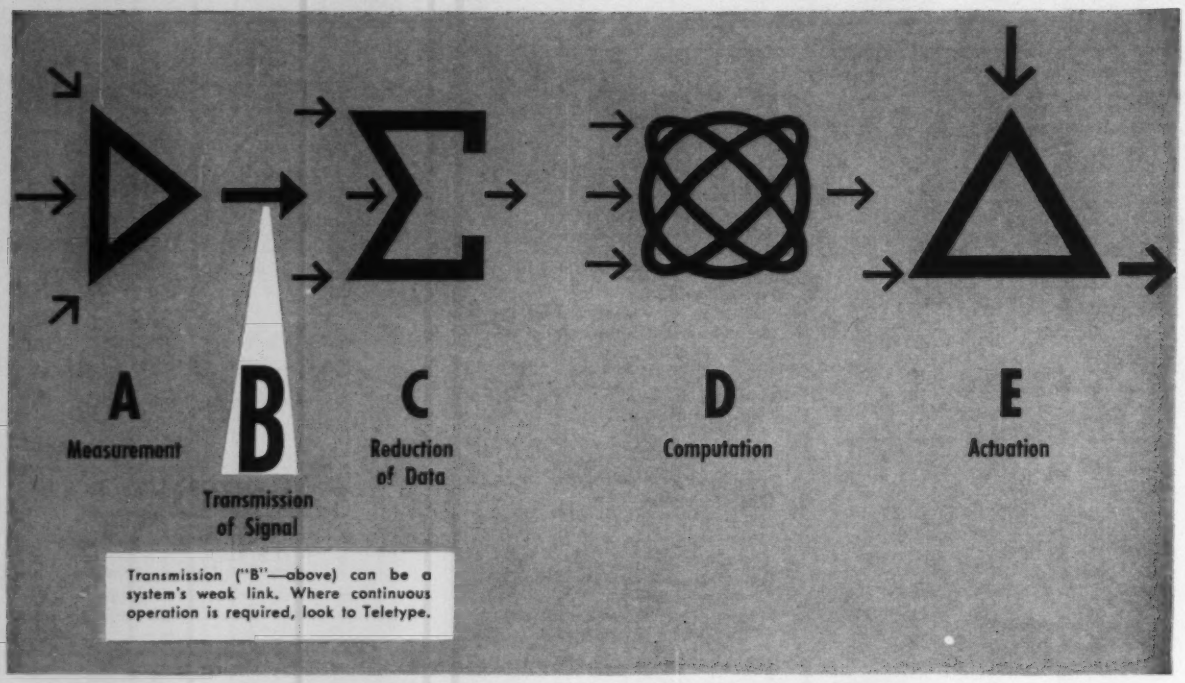

Teletype — Symbol for continuous operation

Teletype equipment was born to demanding applications; railroad stations located too far for servicing, 24-hour newspaper and telegraph jobs, the stock exchange where a breakdown could cost a fortune . . . and rough hitches with the armed forces.

The Model 28 printer incorporates Teletype dependability with a host of new features for communication and data processing applications.

Attention Free. The Teletype Model 28 printer is designed for minimum maintenance. Lubrication interval at 100 word per minute speed is 1,500 hours—at 60 word per minute it's 3,000 hours! Motors were specially designed for the Model 28, to give long, attention-free operation. The printer is not affected by tilting or severe vibration, works reliably even in mobile applications. Other attention-free features:

1 New type box. Characters are contained in a compact, lightweight assembly. Each character is on a separate pallet—type alignment is built in, overscoring and underscoring eliminated. The type box can be quickly removed, without tools, for cleaning or changes in type arrangement.

2 Tests at 100 WPM in continuous operation show 9,000,000 words printed, without servicing. Paper guides and pressure rollers are designed to provide straight-line paper feed, insuring accurate, continuous, paper alignment.

3 All steel clutches give firm, uniform, and accurate engagement, cycle after cycle . . . operate with exceptional stability . . . deliver high torque capable of handling positive and negative loads. Internal expansion principle in clutch design minimizes wear. Lubrication interval is reduced to once or twice a year.

New—Versatile, too. The Teletype Model 28 printer is a new instrument . . . engineered to "cruise" at 100 WPM. It is attractively styled and quiet in operation.

Exclusive with the Teletype 28 Printer is the versatile Stunt Box, which is actually a "robot brain." Responding to keyboard or line signals, it may be used for internal control of extra functions in the Teletype printer and for remote control of associated or other electronic or mechanical equipment.

For more information about this Teletype Model 28 printer—write to Teletype Corporation, Dept. 21C, 4100 Fullerton Ave., Chicago 39, Illinois.

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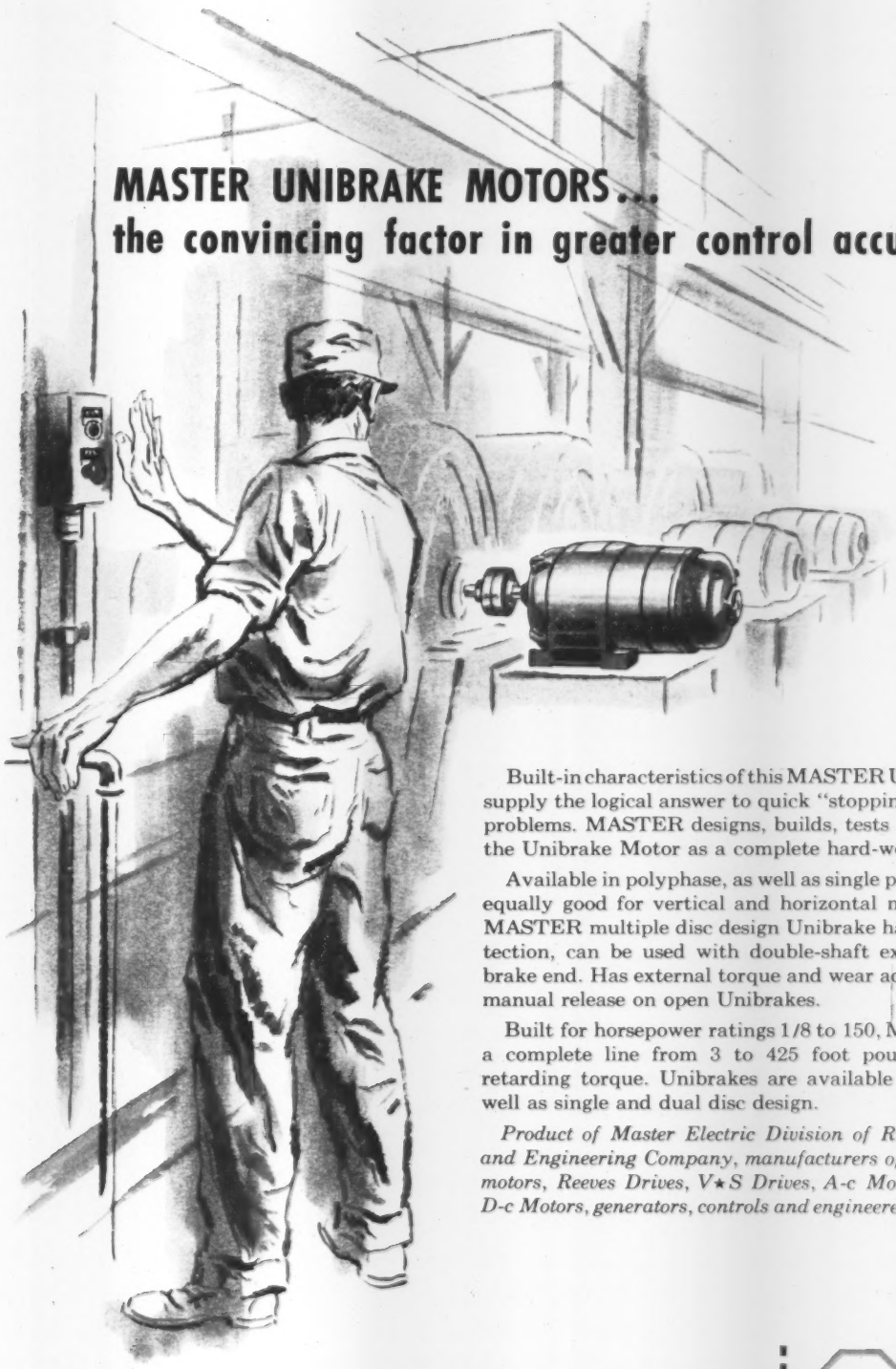

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Available in polyphase, as well as single phase and d-c.—equally good for vertical and horizontal mounting—this MASTER multiple disc design Unibrake has fail-safe protection, can be used with double-shaft extension at the brake end. Has external torque and wear adjustment, plus manual release on open Unibrakes.

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B-1614

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MASTER R REEVES

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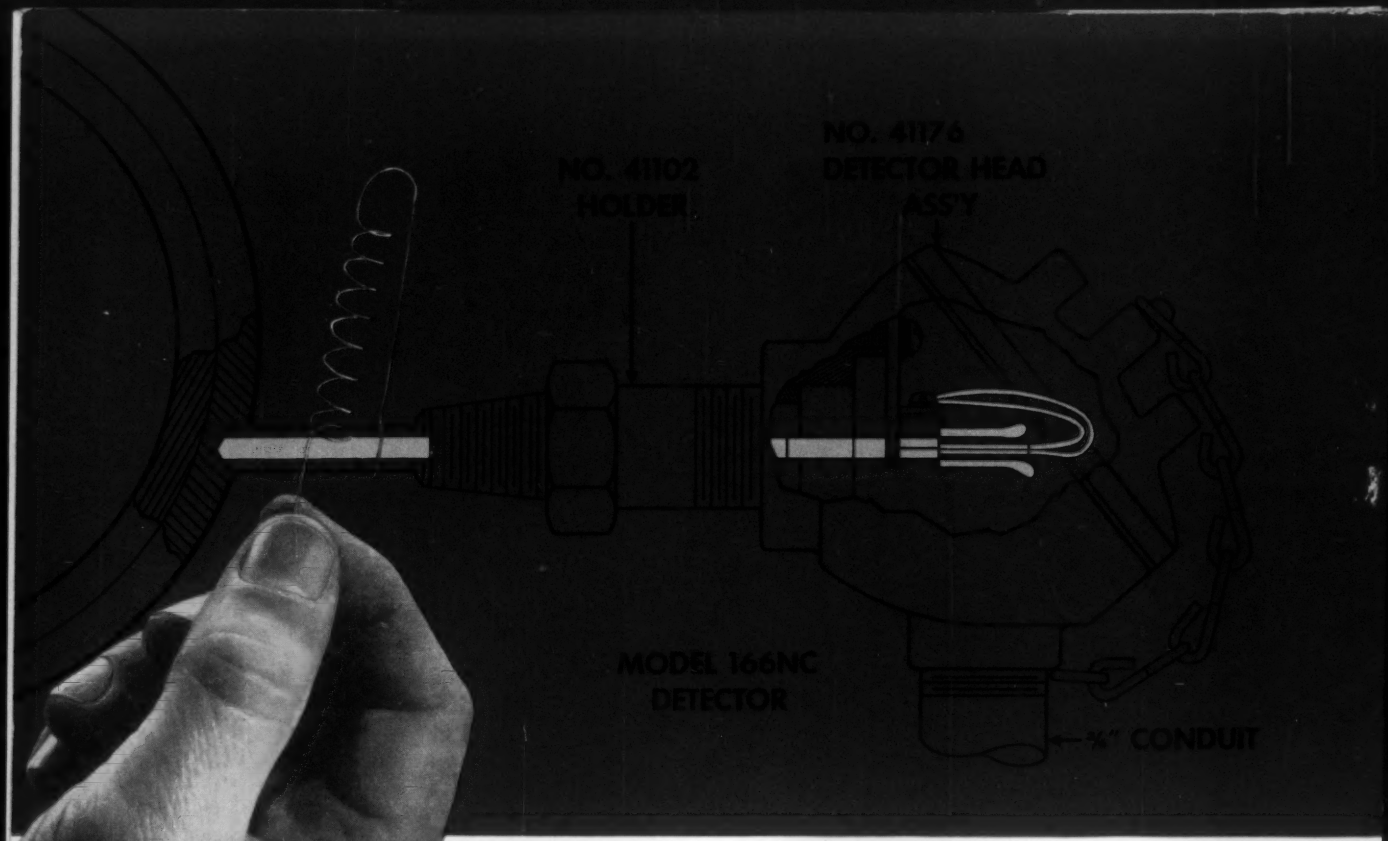

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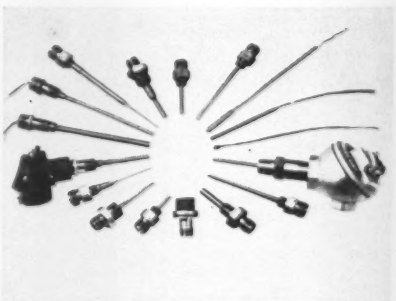
- **Accurate.** As evidence of the unmatched accuracy of the Resistance Temperature Detector, the U. S. Bureau of Standards uses a platinum wire detector for measuring temperatures between minus 300°F and plus 1165°F. Standard Edison detectors are available with accuracy of 0.5%.
- **Rugged.** Edison detectors are designed to withstand the abuse, shock and vibration of industrial applications where other detectors can not survive. Typical of the tough jobs being handled by Edison detectors are sensing applications on the bearings of ore crushers, heavy conveyors, pulverizers and both turbo-jet and reciprocating engine aircraft.
- **For additional information** write for bulletin RTD #3047.



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